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Engineering Library

The Engineer

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Tests for Hydraulic Power Plants.

The Practical Man and Scientific Papers.

Railway Electrification.

Hardness and Cutting Trials of a Tool Steel.

PUBLIC NOTICES

Applications are Invited for the POST of ENGINEER to Take Charge of Design at H.M.S. "Vernon," Portsmouth.

Salary £300, rising by annual increments of £15 to £500, and full Civil Service Bonus.

Present commencing salary, including bonus, £449.

The bonus corresponds to a cost of living index figure of 80 per cent., and is subject to increase or decrease by 1/20th for every five points rise or fall in the index figure.

Applicants should have a sound knowledge of electric technics and physics; a sound knowledge and experience in the design and use of electrical apparatus as applied to modern acoustics; and should be capable of supervising initial manufacture and testing of designs.

Experience in Research or Experimental work will be taken into consideration.

Applications should be forwarded to the Secretary of the Admiralty (C.E. Branch) not later than 19th April. 5425

Assistant Engineers Required by the GOVERNMENT of CEYLON for Railway Construction, for two years' service, with possible extension. Salary £500, rising to £600 a year by annual increments of £30. Should the selected candidate be less than 30, the commencing salary will be £500 per annum. Free quarters or an allowance in lieu. Free passage provided. Candidates, unmarried, preferably between the age of 30 and 35, must be experienced engineers who have received good training and experience on a recognised European or American Railway. Must have a thorough knowledge of surveying, levelling, estimating, setting out, and supervising all works in connection with the location and construction of a railway. Members or associate members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Ceylon 12,610. 5430

Board of Trade.
STANDARDS DEPARTMENT.
A VACANCY exists for an ASSISTANT EXAMINER in the Standards Department of the Board of Trade with establishment in H.M. Civil Service after two years' approved service. The duties are mainly in connection with the control of standards, and with the examination of weighing and measuring apparatus of novel types with a view to their approval for use in trade.

Candidates, who must be British subjects by birth, and the sons of fathers also British subjects by birth, should possess a University Degree (or its equivalent) in Science or Engineering, and should have had practical workshop experience. Preference will be given to ex-Service men.

The salary is £150, rising by £15 to £300 per annum, with bonus, which is re-assessed half-yearly on the basis of the average cost of living figure for the previous six months. The present bonus on £150 is £94 14s., making the total remuneration £244 14s.

Applications, with copies of testimonials, should be made in writing to the Principal Establishment Officer, Board of Trade, Great George-street, Westminster, S.W.1, not later than the 16th April, 1924. 5444

Civil Engineers (3) Required by the GOVERNMENT of CEYLON for appointment as Irrigation Engineers for three years' service. Salary £500, rising by £500 a year by annual increments of £40. (£600 a year will be paid to selected candidates who have attained the age of 30.) Free passages provided. Candidates, 28 to 31 years of age, must have passed the examinations to qualify for Associate Membership of the Institution of Civil Engineers or hold equivalent professional qualifications. Must have had at least three years' practical experience on waterworks or drainage or harbour and dock works.—Apply at once, in writing, giving age and brief details of qualifications and experience and stating whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at head of application M/12,653. 5407

The Manchester Steam Users' Association.

The ANNUAL GENERAL MEETING of the Members was held in the Board Room of the Association at their offices, 9, Mount-street, Manchester, on Tuesday, April 1st, Harold Lee, Esq., J.P. (Manchester), President, in the chair, when the following resolutions were adopted:—

Moved by the Chairman, seconded by J. T. Browne, Esq., Pendlebury (Vice-President), and resolved:—

"That the Report of the Committee of Management to the Subscribers be adopted."

Moved by Oscar S. Hall, Esq. (Messrs. Robert Hall and Sons, Ltd., Bury), seconded by W. R. Griffiths, Esq. (Peel-Conner Telephone Works, Ltd., Salford), and resolved:—

"That the thanks of the Association are due and are hereby presented to the Committee of Management for their past services, and that the following gentleman be elected the Committee for the ensuing year with power to add to their number:—

COMMITTEE OF MANAGEMENT.

Harold Lee, Esq., J.P., Manchester.
A. Norman Dugdale, Esq., J.P., Blackburn.
Jas. Stanley Addison, Esq., London.
J. T. Browne, Esq., Pendlebury.
Alfred H. J. Cockrane, Esq., Openshaw.
Charles W. Crossley, Esq., J.P., Halifax.
Charles Roberts, Esq., Manchester."

JAMES PARR,
Secretary.

9, Mount-street, Albert-square, Manchester.
April 2nd, 1924. 5426

University of Liverpool,

SESSION 1924-1925.

FACULTY OF ENGINEERING.

DEAN: Professor T. E. ABELL, O.B.E., M.Eng., F.C.N.C. Eng., M. Inst. N.A.

Prospectus and full particulars of the following may be obtained on application to the REGISTRAR:—Engineering, Thermodynamics of Heat Engines, Strength of Materials, Electrical Engineering, Civil Engineering, Naval Architecture, Marine Engineering, Metallurgy, Geology, Design and Drawing, Refrigeration, Mathematics, Physics, Chemistry. 5340

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway.
ASSISTANT CARRIAGE AND WAGON SUPERINTENDENT.

REQUIRED for service in the LOCO., CARRIAGE and WAGON DEPARTMENT of the Company in India.

Candidates should be about 25 years of age and have had a good general and technical education; preference will be given to one who has passed the Associate Membership Examination of the Institution of Civil Engineers. They must have served an apprenticeship in the shops of a British Railway Company or Carriage and Wagon Builder of repute, and have had drawing-office experience. Knowledge of Carriage and Wagon Work is essential; men with only locomotive experience will not be eligible.

SALARY.—On appointment Rs. 450 per calendar month, or according to age and qualifications, rising according to the rules in force.

TERMS.—A three years' agreement in the first instance, first-class free passage to India and home again on satisfactory termination of service.

The selected candidate will only be appointed subject to his passing a strict medical examination by the Company's Consulting Physician.

Letters of application, accompanied by a brief record in chronological order of the applicant's career, with dates, together with copies (not originals) of testimonials, &c., should be addressed to the undersigned not later than the 24th April, 1924.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion, 91, Petty France, Westminster, S.W. 1.
2nd April, 1924. 5436

Borough of Poole.

The Corporation of Poole are prepared to receive TENDERS for the SUPPLY and CONSTRUCTION of a NEW BRIDGE over the channel dividing Poole from Hamworthy. The bridge, which will have a total length of 300ft., will consist of Three Reinforced Concrete Spans on each side and One Steel Opening Span of 60ft. clear in the centre of the bridge; this opening span will rest on 2 piers, each pier being made up of 4 cylinders varying from 7ft. to 13ft. in diameter, with top platform of reinforced concrete.

Plans and draft contract can be seen and the specification, schedule of quantities and form of Tender obtained at the offices of the Consulting Engineers, Messrs. Livesey, Son and Henderson, 14, Southplace, London, E.C. 2, on and from Monday, the 31st day of March, 1924, between the hours of 10.30 a.m. and 4 p.m., upon payment of a deposit of Five Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.

Tenders must be on the official form, each Tender in a sealed envelope marked "Poole Bridge." Tenders must be accompanied by the general conditions, specification, and schedule as issued by the Consulting Engineers.

Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Council does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Monday, the 28th of April, 1924.

CHARLES LISBY,
Town Clerk.

Town Clerk's Office, Poole, Dorset.
25th March, 1924. 5324

Chester Waterworks Company.
TO PIPE FOUNDERS, &c.

The Directors invite TENDERS for about 600 TONS of 12in. CAST IRON PIPES, as per British Standard Specification.

Particulars, &c., can be obtained on application to the undersigned.

WM. S. MOSS,
Secretary.

Water Offices, 15, Newgate-street, Chester. 5388

PUBLIC NOTICES

City of Birmingham.
WATER DEPARTMENT.
SALE OF PUMPING MACHINERY.

TENDERS are INVITED for the PURCHASE, DISMANTLING, and REMOVAL of PUMPING MACHINERY, BOILERS, &c., at Plant's Brook Pumping Station, near Minworth, Warwickshire, comprising:—

1 200 H.P. Compound Differential Pumping Engine, in excellent condition, manufactured by Messrs. Hathorn, Davey and Co., of Leeds.
1 100 H.P. Cornish Engine (old).
4 Roots' Boilers (old), Steam Pipes, &c.

Full particulars, together with form of Tender and permit to view, may be had on application to the undersigned.

J. H. BROADLEY,
Secretary.

Water Department, Council House, Birmingham.
25th March, 1924. 5301

City of Nottingham.
NORTH WILFORD POWER STATION.
COAL RECEIVING HOPPERS, &c.—CONTRACT NO. 6.
TO STRUCTURAL ENGINEERS.

The Electricity Committee is prepared to receive TENDERS for about:—

136 TONS of IRON and STEEL WORK, in Stanchions, Ordinary and Plated Beams; Hoppers, Dished and Flat Flooring Staircases, &c.,

required in connection with the above.

Drawings may be seen and copies of the general conditions of contract, specification, bill of quantities, and form of Tender, &c., may be obtained on and after Monday, 7th April, 1924, on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of Two Pounds, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, in the official envelope provided, are to be delivered to the undersigned not later than 9 a.m. on Thursday, 17th April, 1924.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be accepted from firms who conform to the conditions of the contract as regards paying the local standard rate of wages, &c., and to the working rules of the Nottingham district.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham.
29th March, 1924. 5404

County Borough of Wolverhampton.
WATERWORKS UNDERTAKING.
15in. AND 12in. CAST IRON TRUNK MAINS.

The Wolverhampton Corporation is prepared to receive TENDERS for PROVIDING and LAYING about 5400 Yards of 15in. and 2950 Yards of 12in. CAST IRON WATER MAINS, and executing other work in connection therewith, from contractors who pay to the whole of their employees such remuneration and observe such hours of employment as are recognised by the Employers' Unions and Associations of Employers in the several localities where the work is done.

A copy of the specification, quantities and form of Tender may be obtained from Mr. E. A. B. Woodward, Waterworks Engineer, Town Hall, Wolverhampton, upon payment of the sum of £2 sterling, which amount will be returned to each contractor who submits a bona fide Tender, but not otherwise.

Each Tender must be enclosed in a sealed envelope, addressed to "The Chairman of the Water Committee," and endorsed "Trunk Mains," and delivered at my office on or before 10 a.m. on Tuesday, the 15th day of April, 1924.

The right to decline the lowest or any Tender is reserved to the Corporation.

F. E. WARBRECK HOWELL,
Town Clerk.

Town Hall, Wolverhampton.
5th March 1924. 5128

PUBLIC NOTICES

Aberdeen Corporation Electricity Department.
BOILER-HOUSE STEEL WORK.

The Town Council of Aberdeen are prepared to receive TENDERS for the SUPPLY, DELIVERY, and ERECTION of approximately 90 TONS of STRUCTURAL STEEL WORK of British manufacture, CORRUGATED IRON SHEETING, &c., forming an Extension of the Boiler-house at the Ferryhill Power Station.

Specification, drawings, and form of Tender may be obtained from the undersigned on payment of a deposit of Two Guineas, which will be refunded after receipt of a bona fide Tender and the return of all documents and drawings.

Extra copies of the specification may be obtained on payment of 10s. per copy, which will not be returnable.

Sealed Tenders, endorsed "Boiler-house Extension," to be addressed to the City Electrical Engineer and delivered at his office, Millburn-street, Aberdeen, not later than 1 p.m. on the 18th of April, 1924.

The Town Council do not bind themselves to accept the lowest or any Tender.

J. ALEX. BELL,
City Electrical Engineer.

March, 1924. 5395

Hull Corporation.
WESTERN RING ROADS—RAILWAY BRIDGE.
TO PUBLIC WORKS CONTRACTORS AND STRUCTURAL ENGINEERS.

The Corporation are prepared to receive TENDERS for a RAILWAY BRIDGE in connection with the Western Ring Roads. The work consists of Abutments, Wing Walls, Piling, &c., and Steel Frame Girders, Flooring, &c.; total weight of steel work 232 tons. Contractors shall Tender for the whole of the work, but a public works contractor may sublet the steel work, and similarly, a contractor of structural steel work may sublet the abutments, wing walls, piling, &c.

Forms of Tender and other particulars can be obtained at the City Engineer's office after the 12th April on payment of £1, which will be returned to firms submitting a bona fide Tender. Prints of the six contract plans can be obtained on payment of 15s., not returnable.

Remittances must be made payable to Mr. T. G. Milner, City Treasurer and Accountant.

Tenders, endorsed "Tender for Bridge, Western Ring Roads," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's office before Noon on Wednesday, the 23rd April.

The Corporation do not bind themselves to accept the lowest or any Tender.

By Order,
F. W. BRUCKNELL, M. Inst. C.E.,
City Engineer.

Guildhall, Hull.
3rd April, 1924. 5416

Metropolitan Borough of Hammersmith.
ELECTRICITY DEPARTMENT.
TO MAKERS OF COAL DRYING AND PULVERISING PLANT.

TENDERS are INVITED for COAL DRYING APPARATUS as follows:—

ONE COAL DRYER, capable of dealing with 10 to 15 tons per hour;
ONE PULVERISING MILL, capable of dealing with 5 tons per hour.

Detailed information can be obtained from the BOROUGH ELECTRICAL ENGINEER, Electricity Works, 85, Fulham Palace-road, Hammersmith, London, W. 6. 5434

Metropolitan Water Board.
DISPOSAL OF WROUGHT IRON BOILERS (OLD AND DISUSED).

The Metropolitan Water Board invite TENDERS for the PURCHASE and REMOVAL of FIVE OLD DISUSED CORNISH BOILERS, situate at their works in Portsmouth-road, Surbiton.

These boilers may be seen at the above-mentioned works at any time between 9 a.m. and 5 p.m. on weekdays (Saturdays excepted), on application to the Engineer-in-Charge.

Forms of Tender and conditions of contract may be obtained on and after 3rd April, 1924, from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, by personal application (Room 154), or upon forwarding a stamped addressed envelope.

Tenders must be on the official form enclosed in sealed envelopes, addressed to the Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, endorsed "Tender for Boilers, Surbiton," and delivered at the offices of the Board not later than 11 a.m. on Saturday, 12th April, 1924.

The Board do not bind themselves to accept the highest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1.
31st March, 1924. 5400

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PUBLIC NOTICES

Miris Steel Co., Limited (In LIQUIDATION).

The Liquidators invite TENDERS for the INVENTION covered by British Letters Patent Nos. 124,463, 124,464, and 124,465, of the year 1918, under which this Company has so successfully treated steel for the purpose of the same being used for light armour and other purposes.

Tenders must be addressed to the LIQUIDATORS at 34 and 36, Gresham street, E.C. 2, and posted in time to arrive not later than the 14th day of April, 1924. The Liquidators do not bind themselves to accept the lowest or any Tender. A cheque for 10 per cent. of the amount of the Tender must accompany the Tender. Such cheques will be returned if the Tender be not accepted.

Form of Tender can be obtained from the LIQUIDATORS at 34/36, Gresham-street, London, E.C. 2.

P8405

Miris Steel Co, Limited (In LIQUIDATION).

The Liquidators invite TENDERS for the INVENTION covered by British Letters Patent No. 112,412, of the year 1916, and Nos. 124,915 and 124,916, of the year 1918, for the casting of high-speed steel.

Tenders must be addressed to the LIQUIDATORS at 34 and 36, Gresham-street, E.C. 2, and posted in time to arrive not later than the 14th day of April, 1924. The Liquidators do not bind themselves to accept the lowest or any Tender. A cheque for 10 per cent. of the amount of the Tender must accompany the Tender. Such cheques will be returned if the Tender be not accepted.

Form of Tender can be obtained from the LIQUIDATORS at 34/36, Gresham-street, London, E.C. 2.

P8009

Stepney Borough Council.

ELECTRICITY SUPPLY.

The Electricity Supply Committee of the Stepney Borough Council invite TENDERS from responsible contractors for the carrying out of the following, viz.:—

(a) The MANUFACTURE, SUPPLY and ERECTION complete of COAL-HANDLING PLANT, and

(b) The MANUFACTURE, SUPPLY and ERECTION complete of ASH-HANDLING PLANT, at the Council's Limehouse Generating Station.

Copies of the general conditions, specification, form of Tender and drawings may be obtained from Mr. William C. P. Tapper, M.I.E.E., Borough Electrical Engineer and Manager, 27, Osborn-street, Whitechapel, London, E. 1, upon receipt of a deposit of Five Guineas for (a) and of a similar amount for (b). Deposits will be returned to bona fide tenderers after the Tenders have been considered by the Council. Copies of the specifications and drawings may be inspected at the above-mentioned address by appointment.

Tenders, on the form supplied, endorsed "Tender for Coal-handling Plant" or "Tender for Ash-handling Plant," as the case may be, accompanied by the specifications, drawings, &c., issued therewith, must be delivered, signed, sealed and addressed to the Chairman of the Electricity Supply Committee, at 27, Osborn-street, Whitechapel, London, E. 1, not later than Thursday, May 1st, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

JAMES GEORGE PARKER,
Deputy Town Clerk.

Municipal Offices,
Raine-street, Old Gravel-lane, E. 1.
March 19th, 1924. 5392

The Municipality of Singapore.

TENDER FOR STEEL PIPES, VALVES, &c.

Sealed TENDERS, addressed to Messrs. C. C. Lindsay and Peirce, 180, Hope-street, Glasgow (Agents to the Municipality of Singapore), endorsed "Singapore Municipality. Tender for Steel Pipes, Valves, &c.," will be received until 5 p.m. on Wednesday, the 23rd April, 1924, for the SUPPLY and DELIVERY at Singapore of about 4½ MILES of WELDED STEEL PIPE, 33in. internal diameter; about 4½ MILES of WELDED STEEL PIPE, 36in. internal diameter; about 4 MILES of WELDED STEEL PIPE, 30in. internal diameter; together with certain CAST IRON PIPES, VALVES, and SPECIALS. Though lap-welded steel pipes are specified, tenderers are at liberty to offer other makes of steel pipes, but riveted pipes will not be accepted, and whatever make of pipe may be offered must be of British material and manufacture.

Forms of Tender and specification may be obtained from Sir Alex. Binnie, Son and Deacon, 30, Buckingham-gate, Westminster, S.W. 1, or from the Agents to the Municipality on receipt by either of them of a cheque to the value of £3, made out to the Agents, Messrs. C. C. Lindsay and Peirce, which amount will be returned on receipt of a bona fide Tender. Drawings may be seen at the offices of Messrs. Sir Alex. Binnie, Son and Deacon.

The lowest or any Tender will not necessarily be accepted, nor will any expenses in connection with tendering be defrayed. No Tenders will be considered except from actual manufacturers, capable of supplying the pipes at the rate of 100 of each size per fortnight.

C. C. LINDSAY and PEIRCE,
5391 180, Hope-street, Glasgow
(Agents to the Municipal Commissioners of Singapore).

South Indian Railway Company, LIMITED.

The Directors are prepared to receive written APPLICATIONS from duly qualified candidates for the APPOINTMENT of TWO ASSISTANT ENGINEERS on the Company's staff in India.

Candidates, who may be between the ages of 23 and 27 years, must have received a sound general and technical education and must have had two years' practical experience of constructional work under a qualified Civil Engineer or as an Assistant Engineer on the staff of a British Railway Company. Candidates must be Associate Members of the Institution of Civil Engineers, or must have passed one of the qualifying examinations for such membership. Preference will be given to candidates who have had Railway experience.

The appointment, in the first instance, will be for three years, and may be extended, in which case the incumbent would be eligible for promotion to the higher grades when vacancies occur.

The starting salary of the successful candidates will be fixed according to their qualifications up to a maximum of Rs. 650 per month, plus Overseas Allowance of Rs. 150 per month.

The incumbent will be entitled to the benefits of the Company's Provident Fund.

The Company will provide a first-class passage to India, and the salary will commence from the date of sailing.

Applicants must give a full chronological record of their career, stating whether they are married or single, and including details of their education, training, and subsequent experience.

Applications must be addressed to the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1.
31st March, 1924. 5423

Bagshaw's Wrought Iron Pulleys,

as used in Government Departments, are the strongest cheapest, and best in the market. Quick delivery given. Also FRICTION CLUTCHES for all purposes. SHAFTING, WHEELS and PEDESTALS. List free.—J. BAGSHAW and SONS, Ltd., Engineers, Batley, Yorkshire

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 2in to 24in. dia.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 822 x

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 27, Queen Victoria-street, London, E.C. Tel., City 2923 Ex.

NORTH-EAST BRAZIL

is opening up, and there is business to be done in the following Machinery and Plant:—

Acetylene Plant (Lighting & Welding).
Agricultural Machinery.
Coffee (Roasting & Grinding).
Cotton, Gins, pressing & spinning
Confectionery Machinery.
Distilling Plant (small).
Fruit Presses.
Gas Engines and Suction Plants.
Machine Tools.
Petrol Sets (Electric), Lighting & Power.
Rope Making Machinery (Coir).
Sugar Machinery.
Constructional Steelwork (Buildings & small light Bridges).
Soap Making Machinery.
Steam Boiler Engines, Pumps.
Transmission, Millgearing & Contractors' Plant.

Mr. H. Pincus of Pernambuco and Parahyba is now in London, with a view to fixing up Agencies on commission basis, plus a contribution to advertising, travelling and showroom expenses, and will be glad to hear from Manufacturers (who can compete with American Markets).

Write in first instance, with Catalogues, to H. Pincus, c/o P9936, The Engineer Office.

IMMEDIATE ENQUIRY.

Complete Pressing Plant for 40 Tons of Cotton Seed per 10-hour day. Steam-driven Pumps and Engine and Boiler to have a Reserve of approx. 10 H.P.

Plant to deal with Raw Cotton to Thread—10,000 Spindle capacity. P9936

PUBLIC NOTICES

Madras and Southern Mahratta RAILWAY COMPANY, LIMITED.

An ASSISTANT LOCOMOTIVE SUPERINTENDENT is REQUIRED in the Loco. and Carriage and Wagon Department. The qualifications required are as follows:—

A public school education, at least three years' pupillage in the Loco. Shops of a British Railway Company or Loco. Builder, one year in the Drawing-office, and an Engineering Degree or Diploma from a recognised Engineering College. Importance will also be attached to running experience.

AGE.—Not exceeding 24 years.

STARTING SALARY.—Rs. 425 per calendar month, with increase according to the rules in force.

TERMS.—Subject to a strict medical examination by the Company's Consulting Physician, a three years' agreement in the first instance, a first-class free passage to India and home again on satisfactory termination of agreement, which is extensible by mutual consent. Employees are required to subscribe one month's pay yearly to the Company's Provident Fund, and to those of over five years' service a bonus equal to their contribution is credited, both bonus and contributions accumulating at compound interest until retirement.

Applications should be made by letter only, giving details in chronological order with dates of general and technical education and practical experience. Special forms of application, which must be returned by 23rd April, 1924, will be sent to applicants who appear to have the necessary qualifications.

25, Buckingham Palace-road, S.W. 1. 5481

SITUATIONS OPEN

WANTED, an ASSISTANT ENGINEER, for Work in connection with Sewage Disposal Works. The appointment is a temporary one and is at the inclusive rate of £350 per annum.

Applications, stating age, previous experience, and enclosing copies of three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Manchester, not later than 10 a.m. on Monday, 14th April, 1924. 5390 A

WANTED, an ENGINEER, Experienced in Design, Investigation, and Report Work as applied to Steam-electric Power Stations. Duties will require originality in details of design, with particular reference to the turbine room, and ability to negotiate contracts for equipment and write a clear comprehensive specification. Location London.—Address, 5385, The Engineer Office. 5385 A

WANTED by Midland Crane Firm, Qualified ENGINEER to Assist in General Management, Designing, Estimating and occasionally interview clients; to be good Organiser; excellent berth for suitable man. State age, experience and salary required.—Address, 5306, The Engineer Office. 5306 A

REQUIRED, ADVERTISEMENT REPRESENTATIVE for a technical newspaper of high standing. Applicants must have had previous experience in calling on shipbuilders and marine engineers and specialty manufacturers. Must be of good address and have unimpeachable references. Good salary and commission.—Address, P9921, The Engineer Office. P9921 A

REQUIRED IMMEDIATELY for High-class Wood-working Machinery Manufacturers, REPRESENTATIVE for Midland Counties, with good connection preferred.—Address, stating age, previous experience, salary and commission required, 5432, The Engineer Office. 5432 A

REQUIRED IMMEDIATELY, TWO Fully Qualified REINFORCED CONCRETE ENGINEERS; previous experience with specialist firm in calculating and detailing Reinforced Concrete Structures essential. Permanency to right man. State age, experience, and salary required.—Address, P9922, The Engineer Office. P9922 A

TECHNICAL WRITER WANTED for the Editorial Staff of a leading Journal for Engineers, &c.; must have theoretical and practical experience in the drawing-office and workshops and literary ability.—Write, stating age, giving record of experience and sending copies of testimonials, to T. C., c/o Street's, 6, Gracechurch-street, E.C. 3. 5421 A

TRAVELLER WANTED for Eastern Counties to Sell Oil Engines, Pumps, and Air Compressors. Good connection and engineering training essential.—Address, 5412, The Engineer Office. 5412 A

WORKS ENGINEER.—APPLICANTS are INFORMED that the POST advertised on March 21st under Box No. 5243 has been FILLED. P9912 A

WORKS MANAGER for Internal Combustion Engine Works in Midlands; must be thoroughly experienced; good salary for first-class organiser and live man.—H. WOOD, "Minstead," Norley, Frodsham, Cheshire. P8887 A

WORKS MANAGER REQUIRED for Constructional Engineers, employing 120 men, in London; first-class men only, with long experience and thorough knowledge of the work in all its branches need apply; must have held similar position or that of Assistant to Works Manager.—Address replies, stating experience, age, salary required, &c., to 5433, The Engineer Office. 5433 A

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Naval Review at Spithead.

PRELIMINARY arrangements for the naval review, to be held on July 26th at Spithead, were announced by the Admiralty this week. It is expected that about 120 vessels will be present, the majority belonging to the Atlantic Fleet, and the remainder consisting of ships from the Reserve Fleet, which is to be partially mobilised for summer exercises. Ten battleships are to assemble for the review, including H.M.S. Centurion, flagship of Vice-Admiral the Hon. V. Stanley, commanding the Reserve Fleet. It does not appear that any battle-cruiser—with the possible exception of the Tiger—is to take part, as the Hood and Repulse are absent on the Empire cruise, from which they will not return before September, and the Renown is undergoing a refit. There will be seven light cruisers, fifty flotilla leaders and destroyers, and fourteen submarines, besides depôt ships, minesweepers, and other auxiliary craft. While the number of vessels participating will be very much smaller than the fleets that were wont to assemble at Spithead in pre-war days—the largest of which was the immense armada concentrated for the test mobilisation in July, 1914—there will be almost twice as many ships as were present at the Dominion Premiers' inspection on November 3rd last year, and considerably more than were anchored off Southend for the parliamentary naval review in 1919. With the sole exception of the battleship Centurion, all the ships at the forthcoming review date from the war period, having been completed since August, 1914. At the test mobilisation held in that year the newest capital ships were the Iron Duke and Marlborough, both now serving in the Mediterranean. The whole of the cruisers, light cruisers, destroyers, and submarines seen on that occasion have since disappeared. In view of the Wembley Exhibition, the number of sightseers at Spithead in July will probably surpass all previous records. When referring to this review in Parliament on March 18th, Mr. Ammon said that some of the smaller vessels might be brought up the Thames, and a further announcement on this subject is awaited with interest by the London public.

The Tram and Omnibus Strike.

AT the time we went to press last week the tramwaymen had refused an advance of 5s. per week because that offer applied only to the drivers and conductors and not to the inside men. The strike, which began at midnight on Friday, the 21st ult., continued, with the omnibus men out in sympathy. Late last Friday the offer was made of 6s. for the drivers and conductors and 4s. for the outside men, together with a modification of the existing bonus system such that no further reduction would be made until the cost of living reached 67 points, any increase above the present level of 75 carrying with it an advance in pay. These terms were accepted by the men's leaders, but, with an apparent indifference to the public needs, the end of the strike had to be postponed until the offer was reported to the men's executive on Saturday and to the men on Sunday, and then balloted upon on Monday. The result of the ballot was 9428 for acceptance and 4377 against. Where the money to meet the advance in wages is to come from remains to be seen. Much would seem to be hoped for from the establishment of a London Traffic Board. Whether or not there are any grounds for such a hope is not certain, but in any event it looks as if the public would have to pay for the increases.

Waterloo Bridge.

ON Tuesday the Improvements Committee of the London County Council submitted to that body a recommendation for the reconstruction of Waterloo Bridge across the Thames. Rennie's beautiful structure has now been in service for more than a hundred years, but towards the end of last year it was discovered that a settlement had occurred at the fourth pier from the Lambeth side of the river. Mr. Basil Mott was called in to report on the matter, and with his assistance steps are now being taken with the object of arresting the settlement. The Committee is, however, advised that the settlement must be interpreted as a warning that the effective life of the foundations is coming to an end and that immediate steps should be taken to strengthen the foundations and repair the superstructure. As the cheapest way to reconstruct the foundations is stated to be to take down the bridge and re-erect it, the Committee, in view of the restricted width—42ft. 6in.—between the parapets, has come to the conclusion that it would be best to undertake the widening of the bridge at the same time as the foundations are being reconstructed. It is proposed that the new foundations on the upstream side should be made ready and the greater part of the superstructure transferred on to the new piers. The existing defective piers would then be dug out and replaced by new piers and the remainder of the superstructure utilised. In this way the character and identity of the existing bridge would be preserved. During the reconstruction traffic would be accommodated on a temporary bridge on the downstream side. A covering figure of one million pounds has been submitted as an estimate of the expenditure on capital account for the proposed works. Opposition to the scheme has already been expressed by several individuals and bodies principally, it appears, on the ground that it would rob the Charing Cross bridge scheme of some of its objective.

The Lochaber Hydro-electric Scheme.

IT has just been reported that the Lochaber hydro-electric scheme is to be launched this summer. Presiding at the annual general meeting of the British Aluminium Company, Lieut.-Colonel Stephen H. Pollen, Vice-chairman of the company, said that the board had given long and careful consideration to the Lochaber scheme, and it was satisfied that the time had arrived to proceed with the undertaking. The company had, he said, for some time past been in negotiation with the Trade Facilities Act Advisory Committee, and he was pleased to be able to report that, subject to certain conditions, the Committee had decided to recommend the Treasury to attach a Government guarantee to a loan of £2,000,000 for the purpose of developing the hydro-electric works. The Trade Facilities Act had, however, expired, and had to be renewed. Satisfactory agreements also had to be completed with the Treasury, but there was really nothing, so far as he could see, that would prevent the work being begun.

A Lost Shipbuilding Order.

THE very serious effect of the unsettled labour conditions obtaining in the port of Southampton is brought home very clearly by the recent loss to that port of a shipbuilding contract, having a value of a quarter of a million pounds. It is well known that the Great Western Railway Company recently invited tenders for the construction of two cross-Channel steamers of the latest design, to operate on the service between Weymouth and the Channel Islands. We learn that among the firms tendering, the lowest price was quoted by John I. Thornycroft and Co., Limited, of Woolston, Southampton. The order would have certainly been placed with Thornycrofts if the necessary assurance that the contract would be completed in the specified time had been forthcoming, but the lack of confidence in the Southampton labour position has led the railway company to express its regret that it cannot place the order. The firm states that in making the tender its sole object was to secure work for the port, and that the question of profit did not enter into consideration; in fact, that the price quoted would not have allowed profit to be made on the contract. The order for the two ships has been placed with John Brown and Co., Ltd., Clydebank.

Imperial Airways.

ON Tuesday Imperial Airways, Limited, the national air transport company, formed as an outcome of the recommendations made early last year by Sir Herbert Hambling's Committee, formally took over the control of the subsidised aeroplane services which have been run for varying periods by the Handley Page, Instone, Daimler and British Marine Air Navigation companies. The board of the new company consists of Sir Eric Geddes (chairman), Sir George Beharrell, Lieut.-Colonel Frank Searle, Lieut.-Colonel J. Barrett-Lennard, and Sir Samuel Instone, with Sir Herbert Hambling and Major J. W. Hills as Government representatives. Colonel Searle and Major Humphrey, both of the Daimler Airways Company, have been appointed managing director and manager respectively. The company will operate services with the aid of a £1,000,000 Government subsidy between London and Paris, Cologne, Brussels, Amsterdam, Berlin and the Channel Islands, extending these services and developing new routes as time goes on. The air services from Croydon were suspended on Tuesday, and will not be resumed for a short time, in order that the opportunity may be afforded for centralising the separate systems of operation, inspection and control, previously employed by the four companies. Some difficulty has arisen between the new company and the flying and ground staffs of the old undertakings, the pilots and mechanics being it seems, virtually on strike over the alleged intention of the new company to reduce their earnings.

Canal Schemes.

THE fact that an increasing interest in canal transport is being shown in this country, is suggested by the holding of two meetings last week for the purpose of discussing the improvement of existing navigations. At one, held in Exeter, it was decided to obtain the opinion of an expert as to the best means of dredging out the local canal, and to purchase a tug, while at Birmingham an important meeting was held to discuss the provision of an adequate water connection with the sea. There was some discussion as to whether the canal should be made large enough for 100-ton barges or for vessels of 300 tons, but it seems that the 100-ton size received most support. In the opinion of Mr. Neville Chamberlain, it was unlikely that the canal would be a paying concern in itself, but it would help the city indirectly. General Long also supported the scheme and suggested that one of the most economical methods of transport was to convey materials for long distances by water, and then distribute them by motor lorries. Lorries, he said, were not economical for hauls of over 50 miles.

A New Industrial District for London.

IN 1916 the Thames Land Company was formed as a subsidiary company of Lord Cowdray's firm, S. Pearson and Son, Limited, with the object of acquiring undeveloped properties at West Thurrock on the Essex side of the Thames between Purfleet and Tilbury, the intention being to establish a large industrial estate within easy reach of London. The company now owns the freehold of some 3000 acres of land, stretching back from the river about 4½ miles, and having a deep-water frontage of 2 miles. The estate is 18 miles by road from London Bridge, and is traversed by three main roads to London, one of which is the Ministry of Transport's new 80ft. arterial road. In addition, it is intersected by the London and Tilbury branch of the London, Midland and Scottish Railway. The company proposes to sell or lease the land for manufacturing or industrial purposes. It is now promoting a Bill in Parliament for the incorporation of an undertaking, the West Thurrock Wharf and Railways Company, which will construct railways and a wharf for the estate, and carry out the discharging and loading of vessels and the delivery of goods to or from the works. The estimated cost of the wharf is £1,201,000, and of the railways £267,000. The estate will be laid out as a complete scheme, and it is believed that it will offer to industries advantages not possessed by any other property on the Thames or elsewhere.

The Empire Exhibition Strike.

ON Monday some seven thousand building operatives employed at the British Empire Exhibition decided to strike at once to enforce a demand for 2d. increase in wages per hour, which their union has for some time past been discussing on a national basis with the employers. On Tuesday the strikers proceeded by intimidation to induce all other workers at the exhibition—even those employed by some exhibitors on their own stands—to cease work, with the result that in a very short time practically all activity on and within the exhibition buildings came to an end. The strike is entirely unofficial and is not being supported by the Building Trade Operatives' Union. It cannot be too strongly condemned, not only on the ground that it will almost certainly involve a delay in the opening of the exhibition, but because it represents "peaceful persuasion" run mad and a form of industrial blackmail of an unashamed and cowardly nature.

Short-wave Wireless.

MUCH has been published recently about the advantages of short-wave directional wireless, but the Marconi Company does not seem at all inclined to supply technical details of the system as applied to long-distance work, and until more definite information is available the Post Office can scarcely be blamed for neglecting to consider the system. In reply to a question asked by Sir H. Brittain in the House of Commons recently, Mr. Hartshorn said that the Post Office was aware that Mr. Marconi had been carrying out experiments with this system for some years past, but at present there was no evidence to show that the system was capable of maintaining regular and efficient communication of the continuous character required in a commercial service. So far as he knew, the scheme had not been tested over such long distances as those which would be covered by the wireless chain. In view of the letter which the Marconi Company recently sent to the Prime Minister concerning the advantages of this system, it is to be hoped that full information on the subject will be published in order that the Post Office may decide whether this method of transmission really possesses all the merits claimed for it.

The Shipyard Labour Trouble.

ON Tuesday a joint meeting of the shipbuilding employers and workers' representatives took place at St. Pancras Hotel, London, and a separate meeting of the men's representatives was also held. At the latter meeting a resolution was passed declaring the Southampton strike to be irregular and undertaking that the union representatives would meet the strikers with the object of persuading them to resume work and take a constitutional course to secure an advance in wages. In order, if possible, to avoid a national stoppage, the shipbuilding employers have decided to postpone the actual posting of the lock-out notices until Saturday, the 5th inst. If on that date the strike is not settled, notices will be posted declaring a lock-out in all the federated shipyards, which will take place on and after Thursday, the 10th inst., in respect of the members of all unions whose Southampton members have not returned to work by Tuesday, April 8th.

High-tension Transmission Lines.

By ERNEST V. PANNELL.

No. IV.*

SECTION III: SUPPORTS.

Wooden Poles.—The development of long distance transmission has reached a stage where the use of wooden poles is almost abandoned. In practically every branch of mechanical engineering the use of organic materials is only a preliminary stage to the adoption of metal in every constructional detail and line construction has followed this familiar course. Pole timber is rapidly getting more scarce and from principles of conservation steel ought to be favoured. For the transmission voltage used as an illustration throughout these articles, 150 kilovolts, no wood pole lines are in existence. At 130 kilovolts two systems use wood construction with suspension insulators and at 110 kilovolts about three systems. In most cases these poles were installed at a time when deliveries of steel were very protracted and prices high. The poles most used in America are of red or white cedar or chestnut, these timbers being subject to the slowest decay. Only of recent years has the matter of impregnation been seriously handled and for the most part it has been usual to treat the butts—after thorough seasoning—to two coats of carbolineum or creosote applied with a brush at about 200 deg. Fah. In a few instances the power companies are using a treating plant in which the pole butts are steeped in a tank to secure reasonable penetration. The American Telegraph and Telephone Company specifies four to eight hours steeping in hot oil of coal tar, with subsequent soaking in cold oil. The oil is expected to penetrate to ¼in. depth or one-half the thickness of the sapwood, though in wood of open grain, such as yellow pine, it has been found to impregnate the timber to a depth of 3in. Inorganic solutions, such as copper or zinc sulphate, are cheaper than creosote, but do not extend the life of the pole to the same amount.

A pressure tank method of impregnating the entire pole is admittedly far the most satisfactory, but has not been widely adopted on account of the cost of the equipment. The present tendency is to treat only the butt of the pole, but to render penetration more thorough by a preparatory perforation of the outer layer of the pole surface.

Wooden poles are usually installed with a liberal factor of safety, which is called for by reason of the rapid deterioration, especially when they are not treated. Gradual decay at the ground level reduces the strength of the pole, which is proportional to the cube of the diameter. This reduction of the diameter by decay has been calculated to lead to 80 per cent. depreciation in strength after fourteen years' service, and this estimate may be taken as applicable to the generality of pole lines where the simple brush treatment has been applied. On the other hand, after using the hot immersion process above mentioned, only 5 per cent. of the poles installed have shown decay after fourteen years. A great many factors tend, however, to modify the rate of decay.

Burning is usually responsible for far greater losses than weathering. This is especially true in a wet climate, and is due not merely to occasional flashovers but also to relatively insignificant leakage currents which sooner or later reduce the top of the pole to matchwood. The puncture of the insulators on a steel tower involves a dead ground which calls for immediate repair. On a wood pole line the pole itself may provide sufficient insulation to hold the load, but all the time it will be undergoing destruction until it collapses a complete wreck, bringing down the wires with it. The insulating feature of wood is, therefore, a menace. On at least one system in the Western United States where a high-tension line is carried on wooden poles, an iron ferrule has been set around the top of the pole and connected to ground by a galvanised steel wire. In this way burning of the pole top has been eliminated, but, of course, every flashover becomes a dead ground.

One of the most powerful tendencies in transmission design is that directed to the reduction in the number of points of support. The span length of high-tension lines has been gradually increased from 200ft. to 1000ft., mainly with the object of reducing the number of insulators. As the normal span with steel construction is from two to three times that practicable with wood, and as the cross-arm length may be greater and the spacing more liberal even with two circuits instead of one, the further advantages of steel tower construction need not be elaborated. For distribution lines wooden poles are best economically, and not inferior technically, and the same may be said of pin type insulator transmission up to 50 kilovolts. This, however, defines the desirable limit of wooden construction in most circumstances.

When calculating the necessary size of a pole, the strength as already mentioned is taken as proportional to the cube of the diameter by the usual formula

$$\text{Maximum horizontal load } P = \frac{\pi D^3 T}{32 H}$$

where D = diameter at point of maximum stress.
T = maximum stress in pounds square inch calculated with a safety factor of 6.
H = height to plane of load.

The high factor of safety makes allowance for the decay of the butt at ground level, which in eight or ten years generally reduces the diameter by 20 per cent., for chestnut or cedar poles, air treated or brush treated, leading to a reduction in strength of nearly 50 per cent. The use of the tank immersion treatment for the butts is now so universal that this rapid decay may be neglected and a useful life of fifteen to twenty years may be estimated upon the original diameter. This diameter D, being that corresponding to maximum stress, is one and a-half times the diameter at the plane of the load. Actually the load is applied at two or three different planes, and the strength of the pole is calculated simply as a cantilever; the additional compression due to the weight of wires and ice is very nearly negligible.

To obtain greater spacing and transverse strength two poles are generally braced together in an A or H form; the first is not popular because it gives

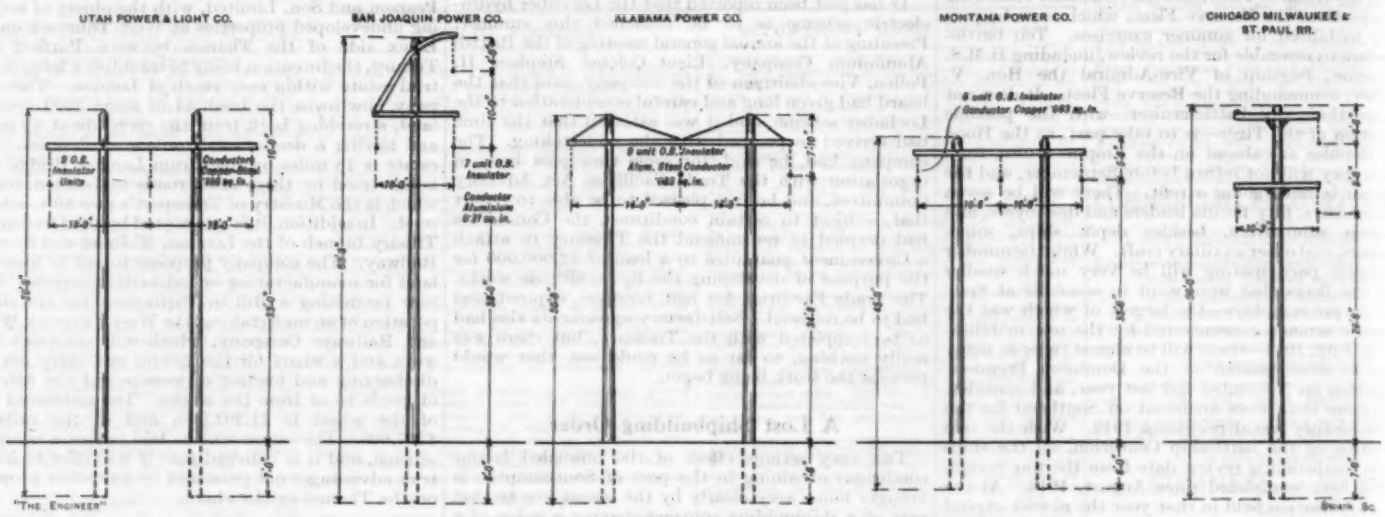


FIG. 18—EXAMPLES OF WOODEN TRANSMISSION LINE POLES

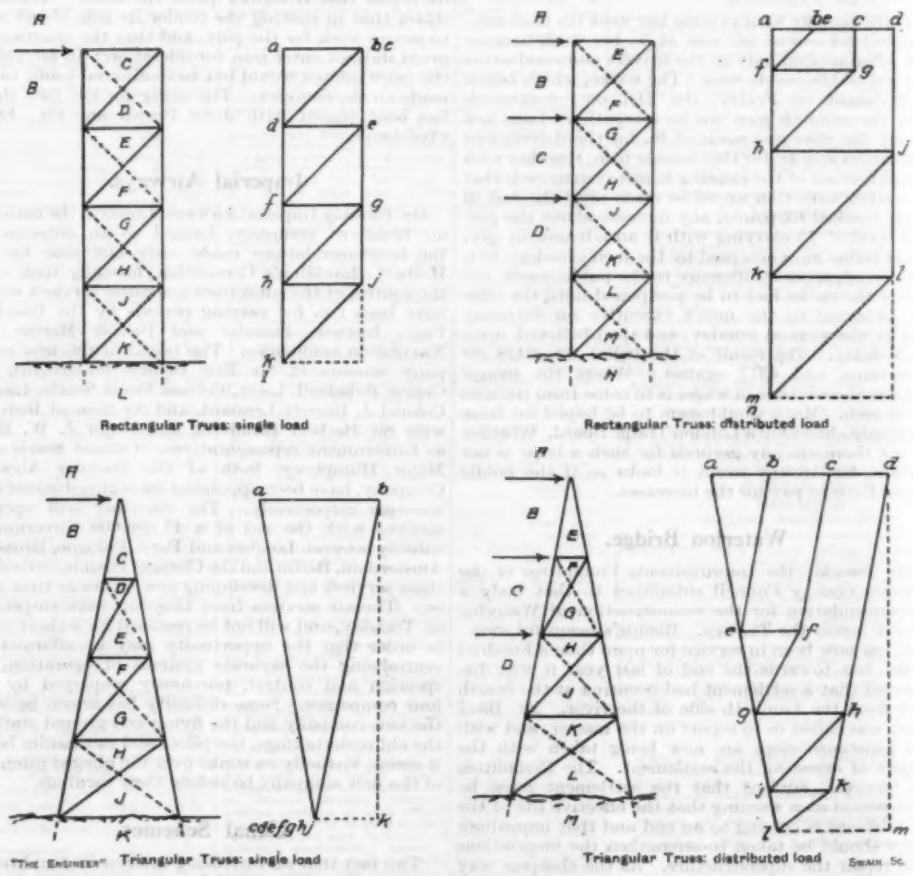


FIG. 19—STEEL TRANSMISSION LINE TOWERS AND STRESS DIAGRAMS

* No. III. appeared March 28th.

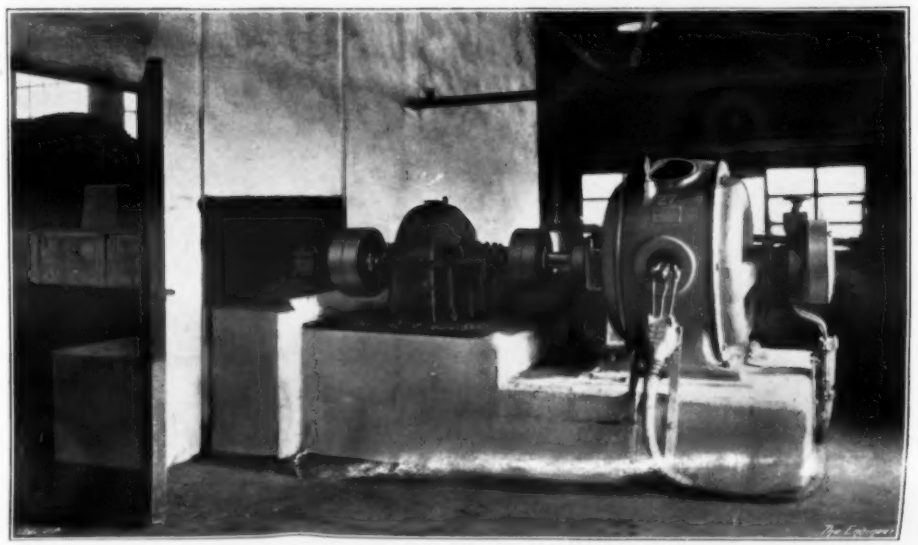
THE WORKS OF THE HUMBER PORTLAND CEMENT COMPANY, LIMITED

MAXTED AND KNOTT, LIMITED, HULL, ENGINEERS

CHALK SLURRY STORAGE TANK AND MEASURING PLANT

CHALK SLURRY STORAGE TANK, WASH-MILLS AND CEMENT SLURRY STORAGE SILOS

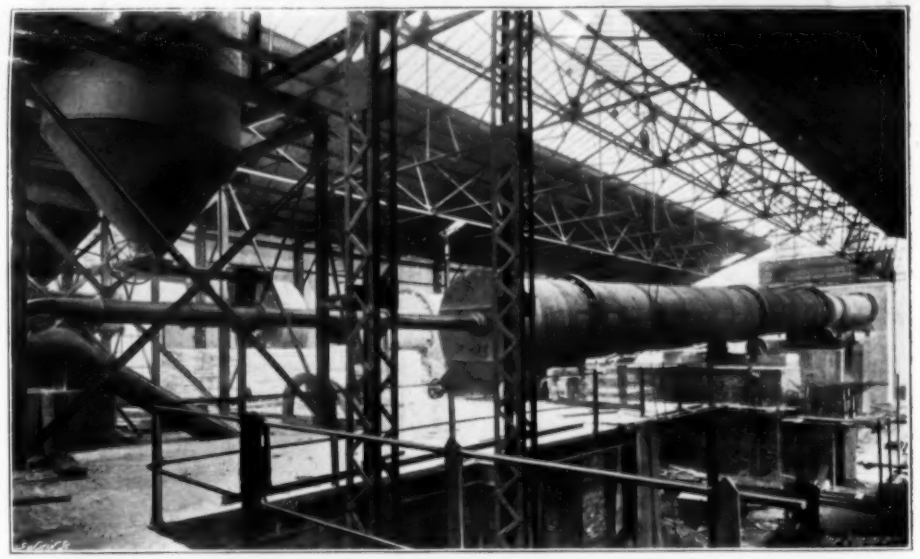
TUBE MILLS FOR GRINDING CEMENT SLURRY



MOTOR AND SPEED-REDUCTION GEAR FOR DRIVING CEMENT SLURRY TUBE MILL

TUBE MILLS FOR GRINDING CEMENT SLURRY

MOTOR AND SPEED-REDUCTION GEAR FOR DRIVING CEMENT SLURRY TUBE MILL



KILN FIRING PLATFORM SHOWING POWDERED COAL HOPPER

VIEW BETWEEN THE KILNS FROM THE FIRING PLATFORM

GENERAL VIEW OF FIRING PLATFORM

VIEW ALONG ONE OF THE KILNS SHOWING FIRING HOOD

very little more spacing than the single pole, and heavy side loads produce a tendency for the poles to rack loose where they are keyed together. On the other hand, the H pole is very extensively used, and for a single circuit line it will yield almost any desired spacing; it has between two and four times the strength of a single pole transversely to the line, and, of course, is twice as strong longitudinally. A line of H poles is usually reinforced at strain positions by a four-post structure.

TABLE VI.—*Characteristics of Wooden Poles.*

(Dimensions of example: 50ft. long, 8in. top, 18ft. 6in. from butt, 7ft. set in ground.)

Timber	Red cedar.	White cedar.	Chestnut.	Pine.
Ultimate fibre stress, lb. per square inch	4200	3600	5100	5700
Safety factor	6	6	6	6
Maximum working stress	700	600	850	950
Maximum horizontal load 40ft. above ground, lb.	5600	4800	6800	7600

Steel Supports.—The adoption of steel poles and towers has been dictated not merely by the more rapid deterioration of wood, but by the increasing voltage of transmission systems. With the older 50 kilovolt lines operating with pin type insulators, a spacing of about 5ft. on an equilateral triangle was usual, there being a single circuit with one cross arm and an insulator at the apex of the pole. Modern transmission construction is based upon a pressure of between 110 and 220 kilovolts, calling for a spacing of 12ft. to 18ft. between wires. A single wooden pole cannot possibly carry a cross arm of the requisite dimensions, and although twin poles—as illustrated in Fig. 18—can support one 110-kilovolt circuit, the span length is seriously limited by the maximum length of pole. Few regular poles can be obtained longer than 60ft., and with 8ft. submerged and a further 8ft. deducted for the length of insulator and distance to the apex, only 44ft. remains for the sag combined with the ground clearance. Whilst on light construction it is possible to space wooden poles as far apart as 600ft. on the level, this span has to be reduced considerably when heavier conductors are used, so that the available span is actually less than half the average figure for a tower line, and the insulators are consequently doubled in number. Furthermore, two distinct lines have to be built to take the place of one double circuit tower line. All these facts have militated in favour of the exclusive adoption of steel construction for high-tension heavy power lines.

TABLE VII.—*Wooden Poles for 100-Kilovolt Lines (see Fig. 18).*

System	Utah P.L.	San Joaquin	Alabama P.	Montana P.	C.M. SP.
Voltage	130	110	110	100	100
Circuits	1	1	1	1	1
Type of pole	H	Single	H	H	Single
Material	Cedar	Cedar	Yellow pine	Cedar	Red cedar
Cross arms	Fir	Steel	Yellow pine	Fir	Fir
Spacing—					
Horizontal	13"	10"	13"	10' 6"	10' 2"
Vertical	—	10"	0	—	9"
Conductors	Copper-steel	Aluminium	Copper	Copper	Copper-hemp
Size	.105	0.21	0.083	.083	.105
Ground wire	Steel	None	Steel	Steel	Steel
Size	2 × ½"	—	½"	3/16"	½"
Pole—					
Height, ft.	55	60	50	45	50
Diameter, in.	17	15	15	14	15
Span, ft.	500	587	600	440	300-1200

Towers or Poles.—Two distinct and alternative classes of steel construction are used, depending upon permissible clearances, right of way cost and other controlling factors. A tower has a broad base, the main posts being sloped or battered at an inclination of one in eight or less. The main posts of the pole, on the other hand, are practically parallel throughout their length, being four angle posts with cross bracing. Whilst the tower is designed as a truss with determinate stresses in every member, the pole is regarded simply as a beam and the lattice members are indeterminate, being put in merely to shorten up the unsupported strut length of the main posts. Taking bending moments around the ground line, it will be seen that the force in the main posts varies inversely with the distance between them; in other words, with the spread of the base. This fact renders the tower a much more satisfactory design than the pole, because with the former the base has a width of about 20ft., whereas with the pole it is of the order of 2ft. only. The same fact renders the tower foundation much more resistant to movement, due to the horizontal reaction, and it is still more rigid in respect of torsion loads arising from a broken conductor. In Germany the lattice pole has been very widely used, but it will be found that practically every pole has to be set in a concrete foundation, and guy wires have often to be applied after construction. The use of this type of construction in America is virtually confined to urban districts where the right of way is narrow.

Rigid or Flexible Towers.—A slight deflection of the support transversely to the line is a serious matter, because its effect is likely to be cumulative until the main post buckles. On the other hand, any such deflection in a horizontal direction is not only less serious, but is also less probable on account of the equalising effect of the tension in the conductor and ground wires. The slightest tendency to swing in one direction is counterbalanced by the increased tension immediately produced in the opposite direction. Reasoning from this, it will be seen that logically a structure needs to have very little strength in the direction of the line, provided it can resist the forces transversely to it. This, however, does not take account of the possibility of broken wires, angles in the line or unequal spans. For straight-line construction in level country, the so-called flexible type of construction possesses certain economic advantages, and is widely used. The individual structures are usually "A" frames, having a heavy channel frame which forms the main posts and bracings all in one plane. At intervals four post towers of regular design are interspersed to act as anchors. The drawback of this type with high-tension systems lies in the very heavy torsional forces produced by the necessarily long cross arms and the construction is far better adapted to lower voltages. On the other hand, the distortion of "A" frames by twisting has led to the development of "semi-flexible" construction, in which the tower base is not a plane, as in the flexible design, nor is it a square as with a rigid tower, but is a narrow rectangle having the greater length across the line. Such construction is heavier than "A" frames, but appreciably lighter than rigid tower construction, and is generally a compromise of strength and economy.

For the heaviest type of power line, where safety and continuous service are paramount, there appears to be no tendency for transmission engineers to depart from the conventional rigid tower designs. Conductors as now used are very heavy, and cross arms very long, so that longitudinal stresses in case of a failure are more significant than transverse ones. Economy is sought, not by making the construction lighter, but by adopting the very long spans which heavy structures render possible. In this way, as already pointed out, insulators are reduced and reliability enhanced.

Elementary Tower Design.—Primarily—as seen in Fig. 19—there are two forms of truss used in tower design, the rectangular and the triangular form, and it may be said that usually both are combined in one structure. For instance, it will nearly always be found that a single circuit tower of the conventional shape, having all the wires in the horizontal plane, has a rectangular truss transversely to the line and a triangle longitudinally to it. Either type of truss may have two forms of bracing, partially or completely diagonal. In the former, the compression loads are all carried by horizontal members, and the tension loads entirely by diagonals. In the latter, the diagonals carry both compression and tension loads with a marked economy in the resulting weight of the tower. The stress diagrams given in the figure are of the most elementary type, and show a concentrated load applied to one point near the top of the frame, and also a load distributed over the surface of the structure. The former illustrates a broken wire and the latter a wind load. Obviously, with an isolated load applied near the apex of the triangle, no stresses will appear in the bracings, and this fact is of importance as related to the manner in which certain towers were calculated and tested some time ago. The test load was applied at the centre of the middle crossarm and was calculated as the resultant of all the horizontal loads which would be experienced in practice. Actually, however, only the main posts were under test and the trial afforded no criterion of the strength of the tower in the field.

The rectangular truss is usually provided with a strut at or near ground level, to take care of the horizontal reaction. This strut is not usually necessary with the battered type, where the slope of the posts provides sufficient resistance to the horizontal thrust. Virtually, the ground represents the horizontal member carrying a stress, and in good ground with secure anchors this ground reaction is perfectly well taken up. Where the ground resistance is at all doubtful, it is usually preferable to put in concrete foundations rather than to change the design of the tower.

In the actual fabrication of the towers, mild steel angles and channels varying in size from 1½in. by 1½in. by ⅜in. are used for secondary members up to 6in. by 6in. by ½in. for the main posts of a strain tower. As almost all the members are in compression at some time, they are practically all angles and no flat lacing is used.

Test Loads.—Any new type of steel pole or tower, as well as any dimension of wooden pole, is frequently tested to destruction by the application of horizontal and vertical loads simulating the most severe stresses to be expected in practice. The loading of towers for test purposes is a subject demanding a certain amount of study and logical reasoning, and the remarks already made in reference to the isolated breast load are significant in this connection. It is now usual to apply loads at the end of one or more cross-arms so as to achieve the maximum unbalanced effect corresponding to a broken wire as well as the transverse wind and vertical weight loads. The intention of the test is to reproduce the most severe weather conditions concurrently with one or more broken wires and with an allowance for the side pull of an angle and the weight of all wires loaded with ice. Such a combination of circumstances is so unusual that it is deemed sufficient for the structure merely to stand this test without any additional safety factor. As will be seen the test forces are applied to the

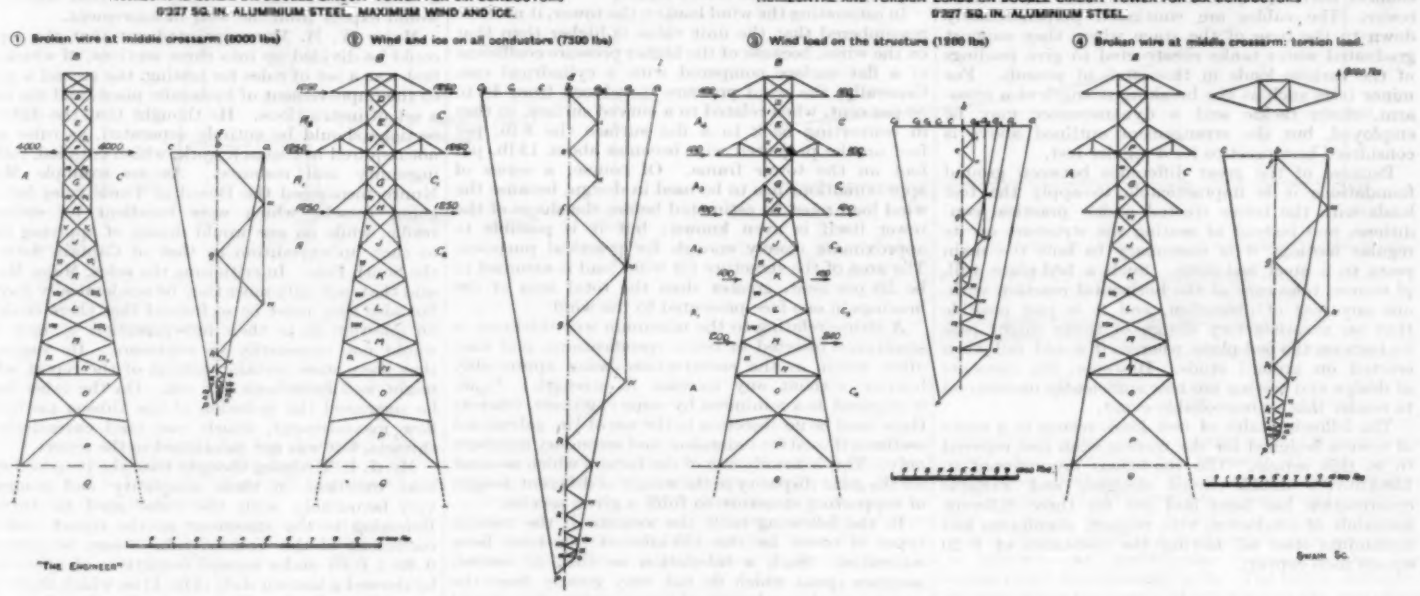

HORIZONTAL LOADS ON DOUBLE CIRCUIT TOWER FOR SIX CONDUCTORS
0·327 SQ. IN. ALUMINIUM STEEL. MAXIMUM WIND AND ICE.
HORIZONTAL AND TORSION LOADS ON DOUBLE CIRCUIT TOWER FOR SIX CONDUCTORS
0·327 SQ. IN. ALUMINIUM STEEL.
① Broken wire at middle crossarm (8000 lbs)
② Wind and ice on all conductors (7300 lbs)
③ Wind load on the structure (1200 lbs)
④ Broken wire at middle crossarm: torsion load.

FIG. 20—TRANSMISSION LINE TOWERS AND FORCE DIAGRAMS

tower in three dimensions:—(*a*) A horizontal load divided between three cross-arms to represent wind on the wires; (*b*) a horizontal load at right angles to this load applied at the end of one cross-arm simulating a broken wire condition; and (*c*) vertical loads hung from the ends of all cross-arms to equal the weight of all conductors coated with ½in. ice. Of these forces the most uncertain to estimate is the broken wire load (*b*). Some engineers specify the maximum tension in any conductor plus an extra 25 per cent. Others call for a test load equal to the maximum conductor tension. On the other hand, it is considered by some that these figures are too conservative, and that even with a sudden burn off of one wire the maximum tension will never be transmitted to the cross-arm because the extra length of the insulator swinging into the span will instantly reduce the load. Furthermore, it is claimed that the average insulator clamp will allow the cable to slip at a maximum tension of about 3500 lb., and that this figure defines the greatest pull which can be transmitted to the structure. As against these arguments it may be said that, even if the load on the crossarm be less than that calculated, it will certainly be applied with impact, the effect of which will be to accentuate it: in regard to the wire slipping through the clamp it should also be remembered that the coating which forms on the surface of copper or aluminium is highly abrasive, and will more than likely cause the cable to seize in the grip. For these reasons it has not been thought desirable in the calculations in this paper to assume the maximum pull on the cross-arm at less than the value of maximum tension in the conductor.

For the actual test at the fabricating plant a pair of tall stages of structural steel or timber is usually provided and reserved for this function. Sheaves are fixed at suitable heights from which cables connect horizontally with the cross-arms of the test tower. The cables are continued perpendicularly down to the base of the stage where they support graduated water tanks constructed to give readings of the various loads in thousands of pounds. For minor tests such as the breaking strength of a cross-arm, chain tackle and a dynamometer may be employed, but the arrangement outlined above is considered best practice for a regular test.

Because of the great difference between ground foundations it is impracticable to apply the test loads with the tower erected under practical conditions, and instead of seating the structure on its regular footings it is customary to bolt the main posts to a steel bed-plate. Such a bed-plate will, of course, take care of the horizontal reaction without any fear of distortion, and it is just possible that an unsatisfactory design of tower might pass its tests on the bed-plate, whereas it would fail when erected on ground studs. However, the elements of design and testing are now sufficiently understood to render this an improbable event.

The following table of test loads relates to a series of towers designed for the transmission line referred to in this article. The conditions are referred to 150-kilovolt double-circuit designs, and suitable construction has been laid out for three different materials of conductor, viz., copper, aluminium and aluminium steel all having the resistance of 0.20 square inch copper.

Table VIII.—*Test Loads for Double-circuit Towers.*

Conductor and span.	Test load, lb. Horizontal transverse.	Horizontal longitudinal.	Vertical weight.
Copper, 700ft.—			
Suspension ..	5,400 (3)	5,000 (1)	6,500 (6)
Semi-anchor ..	5,460 (3)	10,000 (2)	6,500 (6)
Anchor	5,400 (3)	30,000 (6)	6,500 (6)
Aluminium, 650ft.—			
Suspension ..	5,540 (3)	3,370 (1)	5,000 (6)
Semi-anchor ..	5,540 (3)	6,540 (2)	5,000 (6)
Anchor	5,540 (3)	19,620 (6)	5,000 (6)
Aluminium-steel, 950ft.—			
Suspension ..	8,000 (3)	8,000 (1)	9,000 (6)
Semi-anchor ..	8,000 (3)	16,000 (2)	9,000 (6)
Anchor	8,000 (3)	48,000 (6)	9,000 (6)

In Table VIII. the numbers in brackets refer to the number of points between which the specific test load is to be distributed. It is seen that the standard or suspension structure is calculated for the failure of one wire, the semi anchor is designed for two and the anchor tower for the failure of all six, together with the usual wind and ice loads.

Practical Design.—The essential data with which the tower designer is usually supplied by the electrical engineer comprise the height at which the conductors are to be supported, their spacing and the desired test loads which the structure must withstand. sometimes the compression formula and the maximum strut length ratio are also specified. From experience the designer can sketch out a suitable frame to meet the conditions, and then by setting out the force diagrams as indicated in Fig. 20, the individual stresses and weights of members can be calculated. In connection with the force diagrams several points must be observed. The transverse loads will affect two faces of the tower, those parallel to the plane of application of the loads; conversely the longitudinal loads will affect the other two faces at right angles to these. The bracings will, therefore, be designed for whichever of these two is the more severe. But the corner posts will take both these loads and must be designed for their arithmetical sum. The torsion loads are at least as severe as the shear loads, especially on the bracing in the basket of the tower, and must be added to the greater of the two shear loadings before the section of the bracings can be calculated. Weights are usually calculated only on the main posts except for heavy structures. In passing it will be noted that most double circuit towers are symmetrical except as regards the cross-arms. Force diagrams are usually set out for (*a*) transverse wire loads; (*b*) longitudinal wire loads; (*c*) transverse wind load on the tower frame; and (*d*) torsion load due to a broken wire. As there are two parallel faces and two independent systems of bracing on each face, the load must be divided by four before laying out the base of the force diagram. Virtually all members are designed for both compression and tension, and the maximum permissible strut length ratio—being the ratio of length in inches to the least radius of gyration—is fixed at 120 for the main posts and 180 for secondary members. The use of the common straight line formula for maximum working load, however, automatically limits the L/R ratio to a safe figure, the formula being

$$C = 27{,}000 - 90\ L/R,$$

where C is the working stress under maximum load conditions. This is based upon a maximum stress in tension of 27,000 lb. per square inch, which is somewhat below the elastic limit of the material. The other type of formula also in use is—

$$C = \frac{27{,}000}{1 + \frac{L^2}{18{,}000\ R^2}}$$

which gives very nearly the same results as the more simple expression over the range commonly used. For dead end structures which are designed to carry the heaviest kind of load continuously, the above formulæ can be used with stresses 33 per cent. lower to yield an additional safety factor.

In estimating the wind load on the tower, it must be remembered that the unit value is higher than that on the wires, because of the higher pressure coefficient of a flat surface compared with a cylindrical one. Generally, the wind pressure is reduced from 40 to 50 per cent. when related to a curved surface, so that in converting back to a flat surface the 8 lb. per foot on the projected wire becomes about 15 lb. per foot on the tower frame. Of course, a series of approximations has to be used in design, because the wind load must be estimated before the shape of the tower itself is even known; but it is possible to approximate closely enough for practical purposes. The area of the structure for wind load is assumed to be 50 per cent. greater than the total area of the bracings in one face presented to the wind.

A clause relating to the minimum web thickness is sometimes inserted in tower specifications, and may often result in the construction being appreciably heavier without any increase in strength; 3/16in. is required as a minimum by some engineers, whereas there need be no objection to the use of ¼in. galvanised sections, if used for redundant and secondary members only. This is merely one of the factors which account for the great disparity in the weight of different designs of supporting structure to fulfil a given service.

In the following table the weights of the various types of tower for the 150-kilovolt line have been estimated. Such a tabulation as this, of course, assumes spans which do not vary greatly from the average, and an absence of construction of a special type which often increases the aggregate weight and cost.

Table IX.—*Weights of Double-circuit Towers.*

Conductors	Copper.	Aluminium.	Aluminium-steel.
Span	700	650	950
Weight, lb.—			
Standard	8,150	6,820	11,200
Semi-anchor ..	9,700	7,820	13,800
Anchor	14,700	11,000	21,400
Percentage of total towers—			
Standard	85	85	85
Semi-anchor ..	10	10	10
Anchor	5	5	5
Average towers per mile	7.5	8.1	5.5
Total steel per mile of line, lb. ..	64,590	79,590	65,990

Standard Tests for Hydraulic Power Plants.

A joint meeting of the Institutions of Mechanical and Civil Engineers was held on Friday, March 28th, at the home of the "Mechanicals," to discuss the report of the Joint Committee appointed by the two Institutions to draw up a set of recommended rules for the testing of hydraulic power plants. In the absence of Mr. Patchell, the president, the chair was taken by Mr. William Reavell.

The report was introduced by Professor A. H. Gibson, who pointed out that although there were few opportunities in Great Britain for the development of water power, the manufacture of hydraulic turbines was a growing industry in this country. In supplying turbines to oversea countries British engineers naturally came into competition with American and continental manufacturers, and it was consequently desirable that a standard system of testing turbines should be adopted, so that our machines should not be handicapped through being compared with others tested under more favourable conditions. For these reasons the Committee had been set up by the two Institutions with the object of formulating a standard set of rules for testing, and the report was the outcome of its deliberations up to the present time. The tests recommended had been made to cover as wide a field as possible, and were so devised as to be applicable to the most diverse conditions. It was possible, however, that some modifications would be needed in light of the discussion that evening. Professor Dixon spoke in much the same train of thought, saying that the laws of engineering were not like those of the Medes and Persians, and should be altered in the light of experience. It was, he said, imperative that manufacturers should agree as to the method of testing the efficiency of water turbines if they were to compete in the markets of the world. An important item was, for instance, the choice as to which formula should be adopted for the flow over a weir.

Professor F. C. Lea said that, not only would the report be of great assistance to manufacturers in the testing of their turbines, but it might also help towards a more critical examination of plant and to a better understanding of the quantities involved, with the result that designs would be improved and higher efficiencies attained. The problem of measuring water by means of a weir was an important one and should be considered very seriously, as there was a considerable discrepancy between the results obtained with different formulæ. He had, for instance, made a number of experiments on the flow over a weir under a head of from 15in. to 18in. It was arranged in a channel 20ft. long, so that the flow could also be measured by other means. He had used a current meter and the salt solution method of measuring the flow and found that they agreed very well, but gave a result which differed widely from that which one would expect from the weir measurement.

Major W. H. Munro pointed out that the report could be divided up into three sections, of which the first was a set of rules for testing, the second a guide to the improvement of hydraulic plant, and the third a set of instructions. He thought that the different sections should be entirely separated, as rules were not required in research work, which entailed, rather, ingenuity and resource. As an example Major Munro mentioned the Board of Trade rules for sea-going vessels, which were excellent for ordinary traffic, while no one would dream of applying them to such an expedition as that of Captain Scott to the South Pole. In criticising the rules, Major Munro said that, not only must they be academically correct, but also they must be so framed that there could be no question as to their interpretation by men who would not necessarily be engineers. He suggested that there were certain sections of the report which might well have been left out. On the other hand, he suggested the inclusion of the Gibson method of flow measurement, which was used extensively in Ontario, but was not mentioned in the report.

Mr. J. L. Hodgson thought that the proposed rules were excellent in their simplicity and compared very favourably with the rules used in America. Referring to the statement in the report that the coefficient of the Venturi tube "may be taken as 0.99 ± 0.01 under normal conditions of operation," he showed a lantern slide (Fig. 1) on which there were plotted practically all the tests that had been published on Venturi tubes. This graph showed that the statement in the report only applied to the "Kent" Venturi tube, and then only for values of R which were greater than 100. For instance, the value of the coefficient for a "Simplex" Venturi tube when R was 100 was about 0.94. Mr. Hodgson disagreed with the statement that the coefficient of a Venturi tube was apt to "vary somewhat irregularly" at velocities less than 1ft. per second. If it was assumed that the velocity in the throat was ten times that in the main, and that for a well-designed Venturi tube the coefficient did not begin to fall steeply until the value of R had fallen below 50, it could be calculated that the level coefficient could be maintained down to velocities in the main of 0.316ft. per second for a 1in. tube, 0.063ft. per second for a 5in. tube, 0.0063ft. per second for a 50in. tube, and 0.00325ft. per second for a 100in. tube. It would also be seen that for values of R below 50 the variation of the coefficient was not irregular, but definitely followed the viscous instead of the square law.

If any attempt was made to generalise in hydraulic problems on the simple basis of velocity, it almost inevitably led to confusion. The correct basis for such generalisation was the Reynold's criterion, $R = Q\,W/d\,u$, with which comparable results were obtained. He trusted that this criterion would be introduced into the report, as a knowledge of it was becoming increasingly important for hydraulic engineers. Mr. Hodgson also suggested that the simple Pitometer shown in Fig. 3 was preferable to that referred to in the report. This Pitometer had a tip consisting of a simple cylinder bored with up-stream and down-stream holes at opposite ends of a diameter. It was cheap to make, easy to reproduce with accuracy, and gave a constant coefficient in water over the range of velocities which were usually worked with.

Mr. Hodgson pointed out that the report included no simple and accurate method of determining the dis-

charge through closed circular conduits. The square-edged orifice which he had introduced for the purpose some fourteen years ago provided a simple means. The necessary data were given in Fig. 2, which is reproduced from a slide which he projected on the screen. The orifice should be installed two-thirds of the way down a 15 diameter length of parallel piping. The small hole referred to in the formulæ was provided at the top of the orifice to allow any air carried along by the water to pass. The values of the coefficient of discharge given in Fig. 2 would, he said, be found to be accurate to within one-quarter of 1 per cent. for values of a_2/a_1 up to 0.5, and to within one-half of 1 per cent. for values of a_2/a_1 between 0.5 and 0.7. It was inadvisable to use the orifice for which values of a_2/a_1 was greater than 0.7, owing to the difficulty of centring them accurately, and the great importance of measuring the up-stream and down-stream diameters correctly, and the necessity for obtaining a standard distribution of the stream-lines across the section. All these points were of minor importance when a_2/a_1 was small. That such a plate orifice could be used without causing undue loss of head, was shown by the following table, which was calculated out on the basis that a_2/a_1 for the orifice was 0.7 and that the head lost was 46 per cent. of the head produced.

Velocity in main in feet per second.	Head produced in inches of water.	Head lost in inches of water.
4	7.57	3.5
6	17.0	7.8
8	30.3	14.0
10	47.4	21.8

Mr. Hodgson also suggested that the report might be improved by the inclusion of further details of measuring instruments and their manipulation. In particular he pointed out that the single-tube manometer, in which practically all the change of level occurred in one limb, was preferable to the ordinary U gauge, where two limbs had to be read simultaneously. He explained the construction of the manometer with the aid of a lantern slide.

Mr. J. H. Arnfield suggested that it would be of great assistance to turbine manufacturers if the Institution were to make it a practice to collect all available test sheets and file them for record. In discussing the report he pointed out that a type of turbine which was growing in importance was one having a raised head race; that is to say, one in which the runner was actually above the head level, so that the water had to be syphoned through. The arrangement was very convenient with low heads, as it reduced excavation, but it was not referred to in the report. Among other data which he would like to see demanded by the rules were the installation, or not, of an air exhauster, the form and material of the draught tube, the number of buckets in the runner, the use of electric relays in connection with the governor, and the provision of a head intensifier, which increased the apparent head by the ejector action of a water jet in the tail-race. Commenting on Mr. Hodgson's orifice method of measurement, he insisted on the fact that it is most important that the insertion of the measuring apparatus should not alter the working conditions, and that the orifice must reduce the available head. To this Mr. Hodgson replied that the orifice could be made so large, in comparison with the bore of the pipe, that the head lost was insignificant, while the actual loss was not so great as the drop in pressure across the diaphragm, as some of the head was regained after the water had passed the orifice.

Mr. H. D. Cook urged that the rules should be made as simple as they possibly could be, so that they would not look too formidable, as in any case it was difficult enough to persuade purchasers to test their plant. Most of the methods of water measurement mentioned in the report would fail in practical application, as they would entail a constant loss of head. The Venturi tube, for instance, absorbed a certain amount of head, while the Pitot tube was unreliable. There were, however, the Gibson and Allen methods, using salt as a means of varying the electrical conductivity of the water, which were both reliable and cheap. The ordinary salt solution method was quite out of the question on large jobs on account of the cost, as salt would have to be used by the ton. The Gibson method was very pretty, but would cost about £1000 for each installation.

Mr. H. S. Rooke suggested that another method of water measurement which might be included in the report was the calibrated sluice system. With it the water was discharged from the turbine into a tank in which the level was kept constant by regulating a sluice. The sluice was previously calibrated, for given openings and water levels, against a weir. The method had the advantage that it gave direct readings and was convenient for continuous work. Mr. Rooke pointed out that in some stations, such as those at Chester and York, where there were virtually no head and tail races, the cost of arranging for a test would be very high, and in such cases it seemed best to accept the results of tests made by the manufacturers on models. He asked for an explanation of the term "nett rack area" called for in the report, as it might mean the area for the passage of the water or the total submerged area in which the rack was placed. There was, he said, no reference to a run-away test in the report, although one was often insisted upon in specifications, and the expression "time to change load," under the heading of "Governor Tests," was not very clear, but he presumed it referred to the closing time of the governor. In this connection it was desirable that there should be an opportunity for recording on the log sheet the variation in hydrostatic pressure caused in the pipe line by the operation of the governor.

Mr. E. R. Howland referred to the Pitometer as a means of measuring flows, and pointed out that, although it had a varying coefficient which was greater than that of the standard Pitot tube, the coefficients were well known and consequently did not involve any error, while the Pitometer had the great advantage that it would measure very small flows. Contrary to a statement in the report, he had known cases where there was no difference in the results obtained when the water flowed past a Pitot tube and when the tube was moved in still water. The loss of head in a Venturi tube was not, he said, of any great importance where it was used to measure flows under high heads.

Mr. Reginald A. Ryves raised the point as to whether the head recorded in a test should be the actual head being used in the turbine or the maximum head which could possibly be used. He also agreed with other speakers that the code and the instructions of the report should be entirely separate and suggested that it would be good policy if in every hydraulic power plant part of the head or tail race was made of uniform—say, rectangular—section, so that the water could be measured in it. The prime difficulty in measuring by means of a weir was the variation of its frictional resistance; a little slime on the sides, for instance, might increase the discharge by as much as 20 per cent. He advocated a form of weir in which both up-stream and down-stream sides and the ends were well curved, so that the water would flow over easily. There would be no pockets for air to collect in and the surface of the water would be quite smooth. As an alternative he suggested that water could be measured by allowing it to flow through a perforated wall arranged between two weirs. The upper weir would destroy the velocity of approach, a most important matter, while the lower weir would provide a tranquil surface as a datum.

Mr. E. Crewdson said that it would be a convenience if some reference were made in the report as to where the coefficients applying to the formula for tail race level could be found, while it would be a valuable addition if a bibliography were included in the report. He thought it would be advisable to cut out of the report any suggestion for the use of the float method of water measurement, which he himself would never accept; but he agreed that the salt velocity method should be included on account of its simplicity.* He asked for explanations as to the meaning of several items required by the test sheet, including that calling for the discharge area of the runner. The area, Professor Gibson explained later, was the area normal to the buckets. Mr. Crewdson thought that there should be added to the definition of the governor test a more precise meaning of the instantaneous fluctuation in the speed. Was it referred to the speed when the turbine had settled down to the new load, or to the speed previous to the change?

Dr. M. A. Hogan pointed out that it was inadvisable, as was done in the report, to settle on the value of g at 32.2 foot-seconds seconds, as hydraulic plants were frequently built high up in the mountains, where the force of gravity was much less. The rate of flow over a weir given in the report was evidently

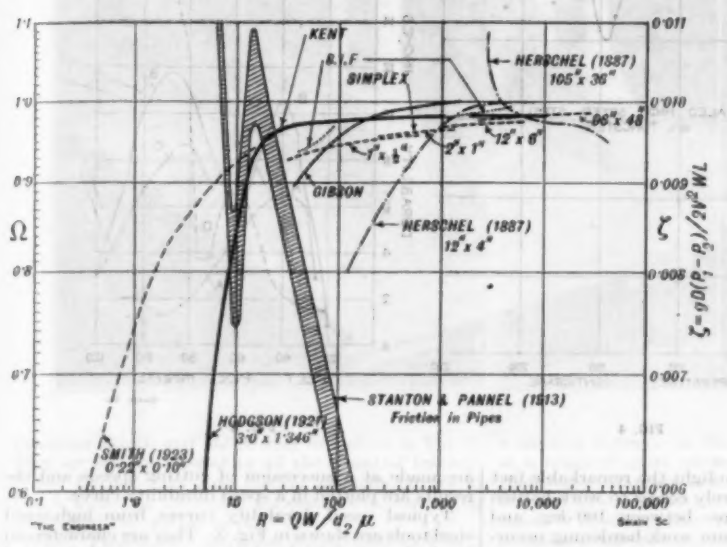


FIG. 1

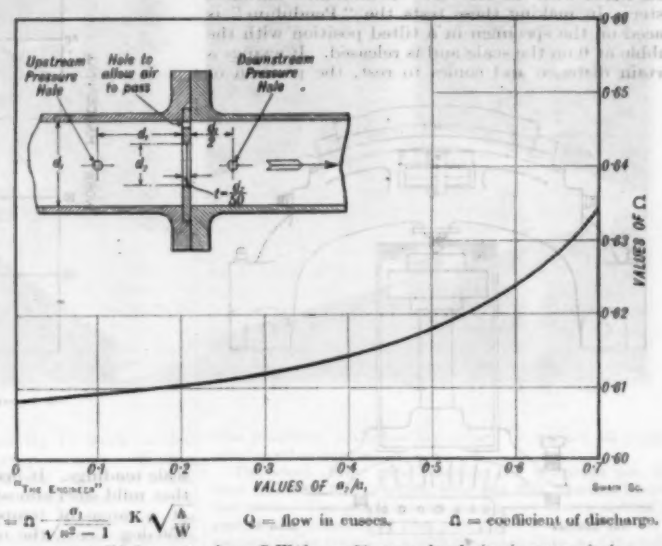


FIG. 2

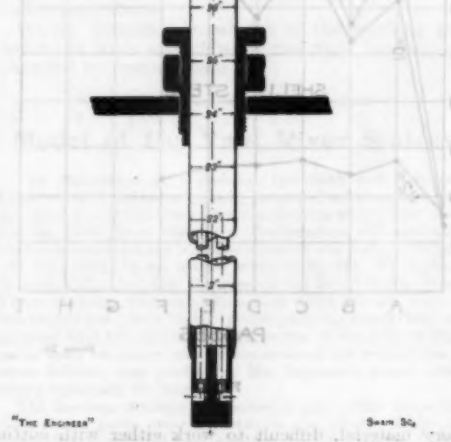


FIG. 3

f = coefficient of friction. g = 32.2.
D = diameter in feet. $(P_1 - P_2)$ = drop of pressure in pounds per square foot.
V = velocity in feet per second. L = length in feet.

$Q = \Omega \frac{a_1}{\sqrt{n^2 - 1}} K \sqrt{\frac{h}{W}}$ Q = flow in cusecs. Ω = coefficient of discharge.
a_1 = area valid for water from $Q W / d_2 \mu = 50$ upwards of pipe in square inches.
a_2 = combined area of orifice and small hole above orifice in square inches.
$n = a_1/a_2$. K = 0.1270.
h = head in inches of water weighing 0.03604 lb. per square inch.
W = density of fluid passing in pounds per cubic foot.
d_1 = diameter in inches. μ = viscosity in C.G.S. units.

* See THE ENGINEER, December 14th, 1923, page 636.

based on Basin's formula and consequently would lower the apparent efficiency of the turbine. That formula gave too much water as flowing over the weir. On the other hand, the formula most commonly used on the Continent minimised the flow, with the result that an apparent gain in efficiency of as much as 2 per cent. was sometimes recorded. This formula was based on experiments carried out in Germany by Rehbok, with a steel weir with glass plate sides, conditions which were obviously inapplicable to practical work. Mr. Percy Pitman made a few remarks on his experiences in testing a turbine in North Wales, and Professor Gibson replied briefly.

Influence of Temperature on the Work-Hardening of Metals.

By E. G. HERBERT, B.Sc.

In the issue of The Engineer for March 7th a description was given of the new "work-hardening" tests made with the Herbert "Pendulum" hardness tester. In making these tests the "Pendulum" is placed on the specimen in a tilted position with the bubble at 0 on the scale and is released. It swings a certain distance and comes to rest, the position of

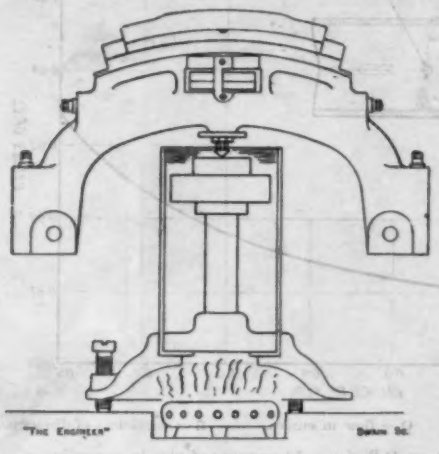


FIG. 1

the bubble on the scale indicating the original hardness of the specimen. The "Pendulum" is then rocked over by hand until the bubble is at 100 on the scale and again released. The effect of rocking the "Pendulum" is to roll out the impression made by the 1 mm. ball and work-harden the area rolled on by the ball. The second reading is made when the ball is rolling back along this work-hardened groove and measures its work-hardness. The numerical difference between the first and second readings is a measure of the work-hardening capacity of the specimen. In most cases the process is repeated until the work-hardening reaches a maximum, but in the tests to be described only the first two readings were taken into account.

Some peculiar effects—referred to later—shown by changes in the durability of a tool when turning a bar in the lathe at different speeds suggested to the writer the idea of measuring the work-hardening properties of mild steel at a succession of temperatures such as might be expected to be generated by the action of a cutting tool.

A bath was constructed (Fig. 1) consisting of a vessel supported on levelling screws and arranged to be heated by a gas burner. Inside the vessel was a table for supporting the specimen. The bath was filled with oil and the temperature was taken with a mercury thermometer.

Tests of two kinds were made at each temperature: "Pendulum" time tests measuring the indentation hardness (corresponding to Brinell hardness), and the work-hardening tests described above.

The results of these tests on a specimen of ordinary mild steel are shown in Fig. 2. The lower curve shows the time hardness. It remains almost constant, with only a slight decrease in the neighbourhood of 95 deg. Cent.

The upper curve shows the work-hardening of the steel—the difference between the first and second

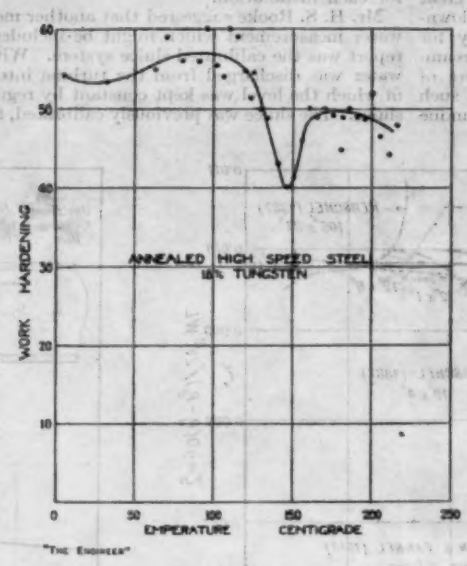


FIG. 4

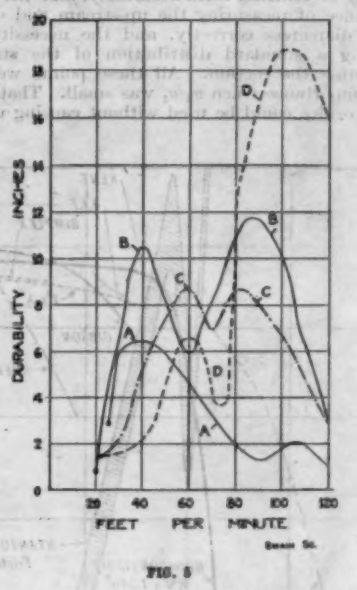


FIG. 5

scale readings. It brings to light the remarkable fact that mild steel almost entirely ceases to work-harden at a range of temperatures between 100 deg. and 150 deg. Cent., the minimum work-hardening occurring at 112 deg. Cent. Above this range of temperatures the steel more than regains its original work-hardening capacity. Complete work-hardening curves of mild steel at 112 deg. Cent. and at temperatures above and below the critical range are given in Fig. 3.

The interesting character of these results led the writer to apply the same method of investigation to a specimen of 18 per cent. tungsten high-speed steel in the annealed state. The results are shown in Fig. 4. In this case the decline in work-hardening capacity was equally marked, though less in degree, the minimum reading occurring at 145 deg. Cent.

The practical importance of these results can scarcely be exaggerated. High-speed steel is a refractory material, difficult to work either with cutting tools or dies. Evidence is accumulating that the resistance which a metal offers to working is due less to its original hardness than to the extra hardness produced by the process of working. It now appears that this capacity for work-hardening greatly declines at a range of comparatively low temperatures, not much above the boiling point of water, and it is a natural inference, which has been confirmed by actual experience, that if the metal is heated to a temperature within this range, the difficulty of working it and its destructive effect on cutting tools or dies will be much less than when it is in the cold state or at a higher temperature.

In 1909 the writer first published results obtained with cutting tools on the Herbert tool steel testing machine. Tool steels to be tested on this machine are made into cutting tools with a single straight edge and are caused to operate on the end of a standard steel tube, cutting it away with a turning action, the tube being fed forward mechanically so that the tool removes a shaving .0012in. thick and .0625in. wide. A micrometer attachment is provided whereby the blunting of the tool can be measured as the cut progresses, and the durability of the tool is measured by the length of tube turned away before the tool attains a standard degree of bluntness. Tests are made at a succession of cutting speeds and the results are plotted in a speed durability curve.

Typical speed durability curves from high-speed steel tools are shown in Fig. 5. They are characterised by the fact that the durability increases with the speed to a maximum, declines and increases to a second maximum, and finally falls off at high speeds.

These durability curves have been the subject of controversy, and although supported by much evidence from the workshop, they were held by some to be peculiar to the special conditions obtaining on the Herbert tool steel testing machine.

In a paper read before the Manchester Association of Engineers on March 28th, 1924,* Mr. Dempster Smith and Mr. I. Hey described a series of tests made on a lathe of standard type, using a tool of ordinary shape and turning a mild steel bar. Special means were devised for estimating the blunting of the tool during the progress of the test, and the durability of the tool was measured by the volume of steel removed by the tool before it attained a standard degree of bluntness.

Durability curves produced on the lathe by Mr.

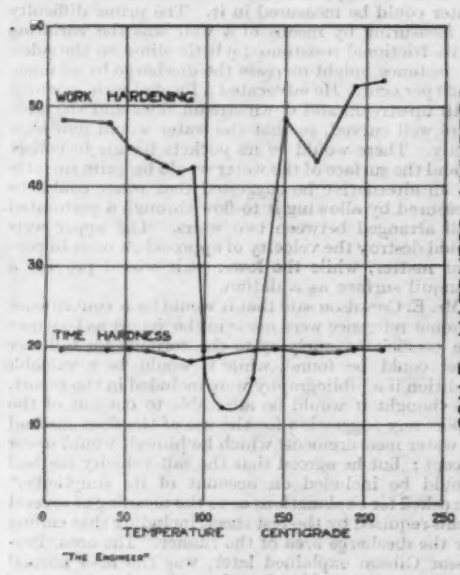


FIG. 2

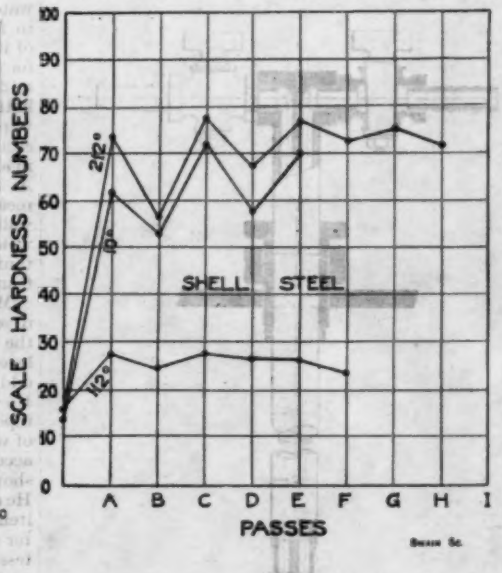


FIG. 3

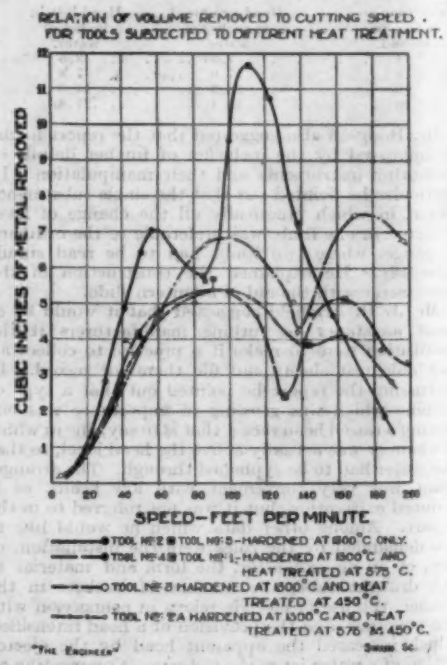
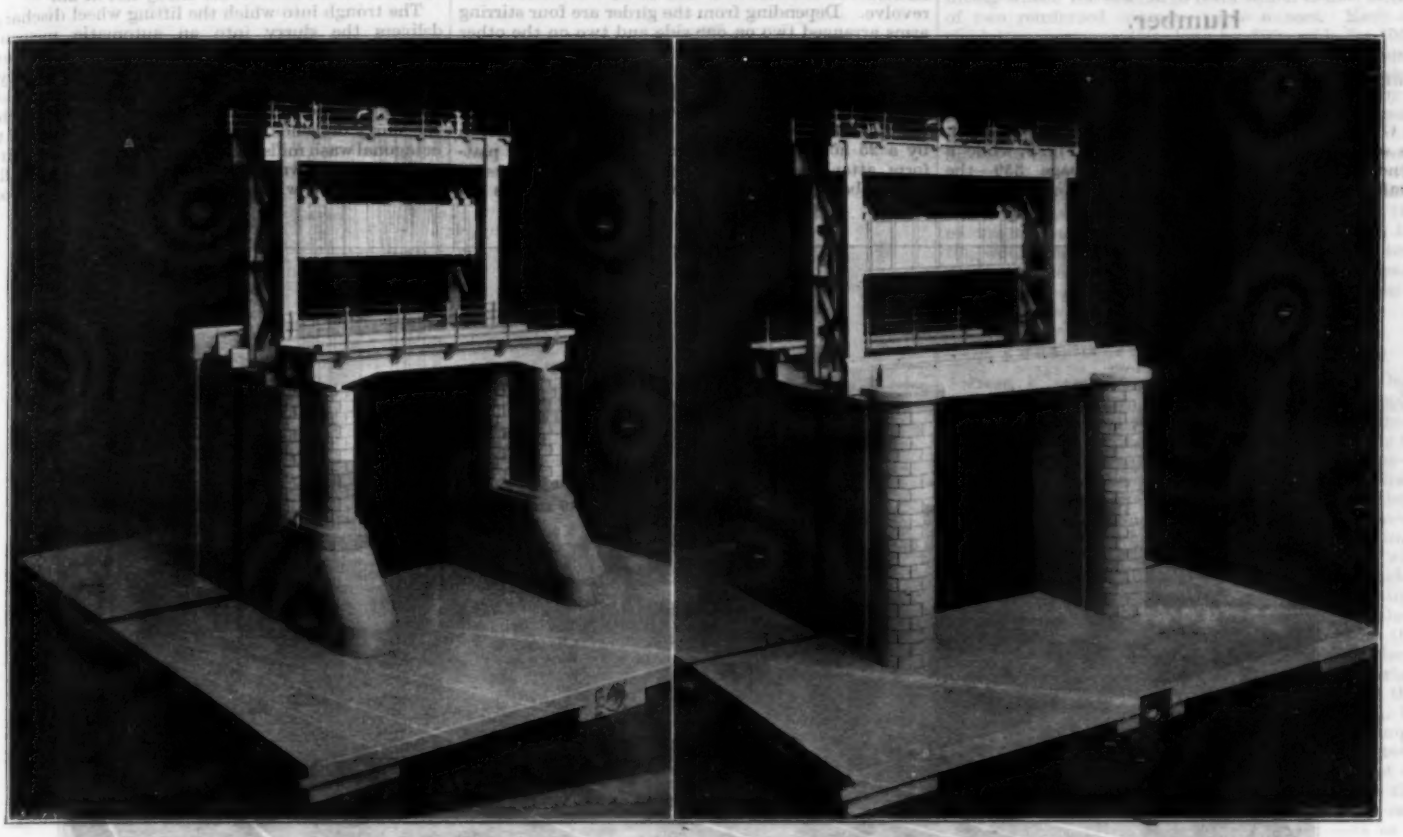

RELATION OF VOLUME REMOVED TO CUTTING SPEED.
FOR TOOLS SUBJECTED TO DIFFERENT HEAT TREATMENT.
CUBIC INCHES OF METAL REMOVED
SPEED—FEET PER MINUTE
TOOL No 2 & TOOL No 5—HARDENED AT 1300°C ONLY.
TOOL No 4 & TOOL No 1—HARDENED AT 1300°C AND HEAT TREATED AT 575°C.
TOOL No 3 HARDENED AT 1300°C AND HEAT TREATED AT 450°C.
TOOL No 2A HARDENED AT 1300°C AND HEAT TREATED AT 575°& 450°C.
"The Engineer"
Dawson Sc.

FIG. 6

* An abstract of this paper appears elsewhere in this issue.—Ed. The E.

MODEL OF SLUICE GATE FOR THE VAAL RIVER BARRAGE.



Dempster Smith and Mr. I. Hey are given in Fig. 6. They are seen to reproduce all the essential features of the Herbert tool steel testing machine curves in Fig. 5, including the rising durability with increasing speed, and the double peak.

The "Pendulum" work-hardening tests in Fig. 2 were made on a piece of the actual mild steel bar used in the lathe tests, the results of which are given in Fig. 6.

It is impossible to resist the conclusion that the hollow in the work-hardening curve Fig. 2 and one of the peaks in the durability curves Figs. 5 and 6 are manifestations of the same phenomenon. The mild steel loses its work-hardening capacity at a certain range of temperature. The tool used to cut that mild steel shows increased durability at certain speeds, which must correspond to certain definite temperatures generated in cutting. The tool lasts longer because the bar does not work-harden under its action.

One peak of the durability curve is completely explained; what of the second peak? If the first peak is due to changes taking place in the bar at certain temperatures, it seems probable that the second peak is due to changes taking place in the tool at certain temperatures. The precise nature of these changes is at present a matter of speculation. The effect actually manifested by the second peak in the durability curve is an increased capacity to resist abrasion at certain speeds, and therefore at certain temperatures. Apart from a cutting test, the writer is not acquainted with any abrasion test which can be conveniently carried out at a definite range of high temperatures.

Naturally one would inquire whether the increased capacity to resist abrasion is caused or accompanied by increased hardness of the tool at certain temperatures. "Pendulum" time tests have been made on hardened high-speed steel in the bath illustrated in Fig. 1, but the results are so far inconclusive.

A cutting tool is usually much hotter than the bar it is cutting. Apart, therefore, from the fact that what is assumed to be the "tool peak" usually occurs at higher speeds and therefore at higher temperatures than the "bar peak," it is almost certain that the tool temperature corresponding to a given speed is considerably higher than the bar temperature corresponding to that speed.

Satisfactory "Pendulum" tests at high temperatures have hitherto been difficult to carry out because the steel ball, being made of carbon steel, becomes softened by contact with steel at high temperatures. Certain steps have been taken to overcome this difficulty, and the investigation is being pursued, but it is not at all certain that the increase of abrasive resistance will be found to coincide with an increase of hardness. If we judge by the analogy of the curves in Fig. 2 it will not, for it cannot be too strongly emphasised that the important change which has been found to take place in the bar is not a change of hardness, but a change in the capacity of the steel to work-harden under the action of a tool.

From the above facts the following conclusions may be drawn:—

(1) Certain steels in the unhardened state exhibit a marked decrease in their capacity to work-harden at a range of quite moderate temperatures. Within that range they are not only much easier to work, but are less destructive of the tools used to work them. Whether this remarkable phenomenon is common to all varieties of steel and whether it occurs in non-ferrous metals has yet to be determined. Temperature work-hardening determinations are not difficult to carry out with the "Pendulum" hardness tester, and special appliances have been designed to facilitate the process.

(2) A tool used for cutting metal attains a maximum durability when the cutting conditions are such as to raise the temperature of the work to the critical range where its work-hardening capacity is at a minimum.

(3) A cutting tool usually exhibits a second maximum durability, which is assumed to be due to further changes, the nature of which is not yet known, which occur either in the tool or in the metal operated upon at a range of temperatures different to the first.

(4) To ascertain whether a tool will possess great durability under cutting conditions which generate high temperatures it is useless to apply any tests to it in its cold state. The utmost utility of such tests is to eliminate tools which are either soft or over hard.

(5) The fact that a tool retains its hardness at high temperatures may or may not be conclusive evidence that it will be durable at high speeds or under heavy cuts, but if the tool can be shown to become soft at such temperatures this is conclusive evidence that it will not work under cutting conditions which generate high temperatures.

(6) An adequate knowledge of the working properties of tools and of work materials can only be obtained by testing them hot.

Model of the Vaal River Sluices.

For exhibition at Wembley, Glenfield and Kennedy, Limited, of Kilmarnock, have prepared an excellent scale model of one of the free roller sluice gates which they made for the Vaal River Barrage. Our readers will remember that this undertaking was described in our issue of December 1st, 1922, in an article written by Mr. W. Ingham, M. Inst. C.E., the Chief Engineer of the Rand Water Board. Views showing the up-stream and down-stream faces of the model are given in the accompanying engraving, and in order that the size and construction of these large sluice gates may be more readily understood we reproduce, in what follows, that portion of Mr. Ingham's article which refers especially to them.

The Barrage consists of a series of piers with large mild steel sluice gates erected between the piers. There are thirty-five piers and two abutments, thus giving thirty-six openings, which are closed by thirty-six gates. Each pier is 9ft. thick, 34ft. 0in. high, and 55ft. long, and the foundations for the piers were carried down into the solid rock below the apron foundation. The concrete mixture for the piers was 5 : 2½ : 1. The average depth of the pier foundations was about 6ft. below the surface of the rock, and the concrete is strengthened by heavy steel rails to prevent damage in case a gate should run down quickly at any time. The gear for operating the gates is placed on a platform 35ft. above the top of the piers, and the platform is supported by a series of reinforced concrete columns 2ft. 0in. square, well braced together by cross members. The platform, main and secondary beams are all made of reinforced concrete.

The steel sluice gates closing the openings are 25ft. high and 32ft. 6in. in width, closing a 30ft. opening between the piers. The gates are let into a slot in the side of the piers for a distance of 18in. In these slots are placed the vertical roller trains on which the gates slide, and the rollers run on cast iron machined liners, which are bolted securely to the concrete of the piers. Each gate weighs about 26 tons, and to enable the lifting and lowering to be carried out easily the gate is balanced by a counterweight of about 60 tons, as the counterweight only travels through half the distance that the gate travels. The gate is attached to the counterweight by means of two $1^{7}/_{16}$in. diameter flexible galvanised wire ropes; each rope passes over and around a double conical grooved drum, then over a pulley attached to each end of the counterweight, and the free end is attached to an adjustable capstan erected on the top platform. The conical drum was designed to overcome certain difficulties of operation; for instance, when the gate is closed the rope attached to the gate lies on the small diameter of the cone, while the end of the rope from the counterbalance lies on the large diameter of the cone, so that when a gate is being opened the counterbalance acts on a greater leverage than the balancing leverage of the gate, and consequently the greatest force is exerted at the start. Immediately movement commences the diameter of the cone on the counterbalance side decreases, while that for the gate increases until about halfway through the full travel of the gate, when the ropes lie on equal diameters; after this point the cone diameter for the gate is greater than that for the counterbalance, and thus an adequate braking effect is introduced which brings the gate to rest.

It must be remembered that the total moving loads are about 82 tons, and as the gate travels through a distance of 23ft. in about one and a-half minutes the forces brought into play are very considerable. In addition to the automatic braking, a fly-wheel 33in. diameter and weighing 400 lb. is connected through the operating gear and acts as a damper in preventing excessive speeds from being built up during the earlier portion of the travel. The two drums for each gate are connected by a 3½in. diameter steel shaft, with the operating headstock placed in the middle of the shaft. When a gate is to be raised a clutch is withdrawn, and this frees the gear; the counterbalance then raises the gate to a predetermined height, and this point has been fixed at 21ft. above the sill of the gate with a full reservoir. To close a gate the clutch is replaced and the gate is lowered by hand through worm gearing. This operation will take two men about twenty minutes, so the whole of the gates can be closed in about twelve hours.

Provision has been made to raise the gates about 7ft. 4in. above the highest known flood level, which was about 26½ft. deep in November, 1917.

Up-stream of the slots in the piers which house the ends of the main gates a further set of slots is provided for inserting a spare gate to close the opening should it be necessary at any time to remove the main gate for repairs, and two spare gates are available for this purpose. In order to remove the spare gate easily a valve has been fixed in the gate so that water can be allowed into the space between the gates.

A railway track has been laid along the whole length of the Barrage, on which a Goliath crane, driven by a petrol engine, travels for transporting the gates. The track is carried from pier to pier on reinforced concrete girders, which are 10ft. apart. The whole of the excavation and concrete work was carried out departmentally, but the gates were made by Glenfield and Kennedy, Limited, of Kilmarnock, to the design of the Chief Engineer of the Board. Blane and Co., Limited, Johannesburg, are the local agents for the makers of the gates.

A New Cement Works on the Humber.

No. II.*

The Slurry Tank and Measurer and the Wash Mills.

On arriving at the cement works—a view of which, as seen from the railway, is given in Fig. 9, while a general lay-out plan is shown on page 359—the chalk slurry is delivered into a large circular reinforced concrete tank, 66ft. in diameter and 11ft. deep, of which some 7ft. are below ground level. The tank—see our Supplement—which is designed to hold about 1500 tons of slurry, is furnished with a stirring device of the sun and planet type. The latter comprises, first of all, a horizontal steel lattice girder, about 66ft. long, which is supported at the centre of its length on a vertical shaft, constructed in the centre of the tank, on which it can revolve. Depending from the girder are four stirring arms arranged two on one side and two on the other side of the central supporting shaft, corresponding arms on either side being fixed at the same radius so that they balance one another. All these stirring arms, which reach down very nearly to the bottom of the tank, are revolved by means of gearing driven by a 25 horse-power electric motor fixed on a platform attached to the lattice girder, the necessary current being obtained from wires stretched across the top of the tank. The reaction between the revolving stirring arms and the slurry causes the slow revolution of the lattice girder so that, not only do the stirrers themselves revolve, but they are taken slowly round and round in the tank, the result being that the whole body of the slurry in the tank is being continually agitated and the solid matter contained in it prevented from sinking to the bottom. The bottom of the slurry tank is connected to a sump into which dips the lower rim of a lifting wheel. The latter is about 28ft. in diameter, and it is driven by a 10 horse-power motor. It is made up of light steel strips and sections, and fitted at intervals round its periphery are double elm buckets which scoop up the slurry, lift it and discharge it into a trough just as they travel in turn past the vertical line. This method of lifting the slurry would at first sight appear to be a reversion to an old practice, but it is by no means certain that the slurry wheel in its improved form as made to-day is not superior to the more recently introduced bucket elevator, bearing in mind its simplicity and comparative freedom from wear and tear. At any rate, it is employed in the Humber Cement Company's works in several places, and the bucket elevator for slurry not at all.

The trough into which the lifting wheel discharges, delivers the slurry into an automatic measuring machine, driven by a variable-speed motor of 5 horse-power, which passes forward exactly the quantity of slurry required at any given time, the surplus being returned to the sump. From the measuring machine the slurry descends by gravity to one or other of two octagonal wash mills, being made, in the case of either mill, to flow down an inclined shoot in an even film. The wash mills, which measure 20ft. between opposite faces, are of the usual type, having harrows depending from horizontal arms connected to revolving vertical shafts driven by bevel gearing by a 75 horse-power motor. The clay, which is brought from the workings—of which mention was made in our first article—in side tipping trucks, is taken to one or other of the two mills on either of the branch lines, and is shot by truck-load down the same shoot as that down which the slurry flows. There is a weighbridge over which the trucks pass just before they reach the wash mills, but at the time of our visit the weighbridge belonging to the one mill which was in operation, was not being used. The men, as is often the case in cement mills, have by practice become so expert in judging when more clay is required, that, as a general thing, no weighing is done. If, as the result of analysis the slurry is found to need either more clay or more chalk, the men in charge of the clay shoots are immediately informed, and they make the necessary adjustments, but it is wonderful how near to the correct mixture the slurry is kept.

After passing through the straining gratings of the

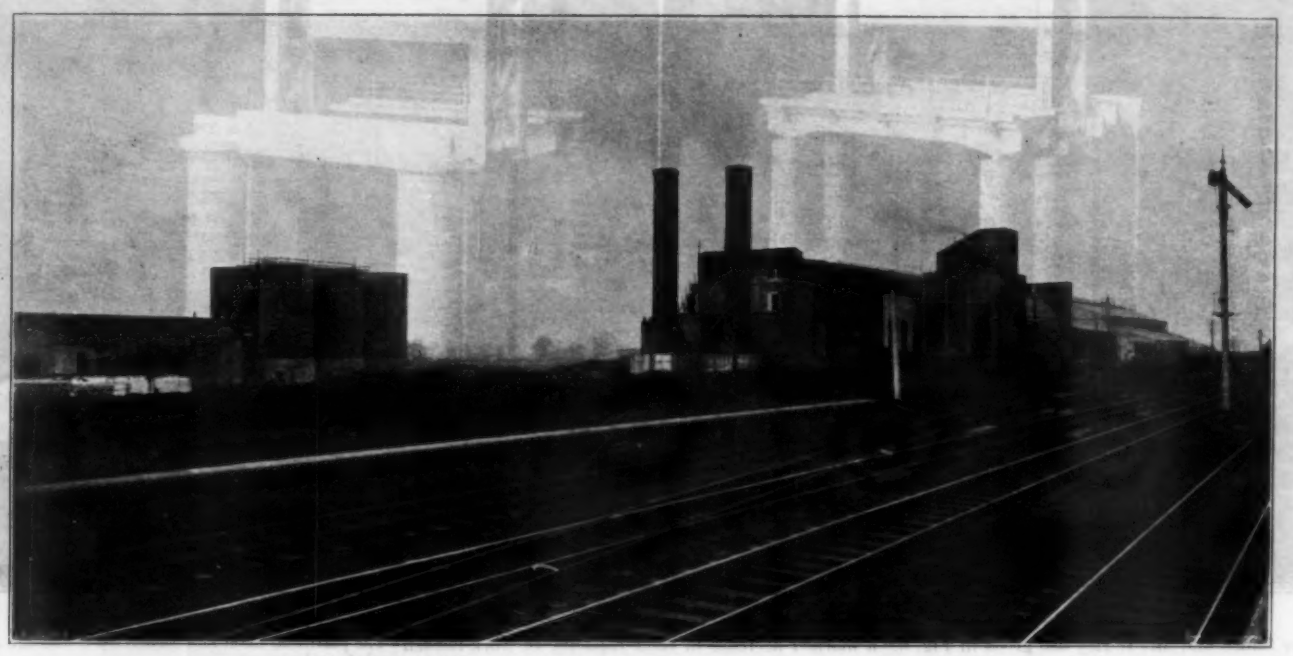
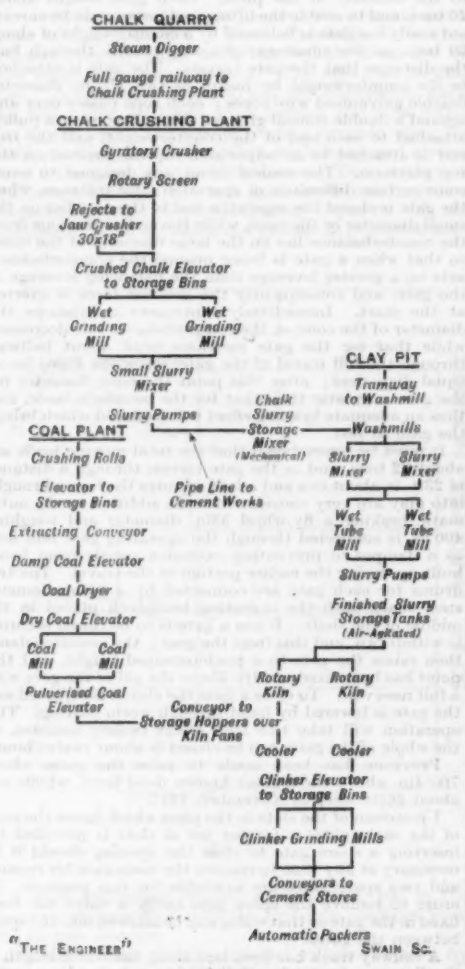


FIG. 9—GENERAL VIEW OF THE WORKS FROM THE RAILWAY STATION



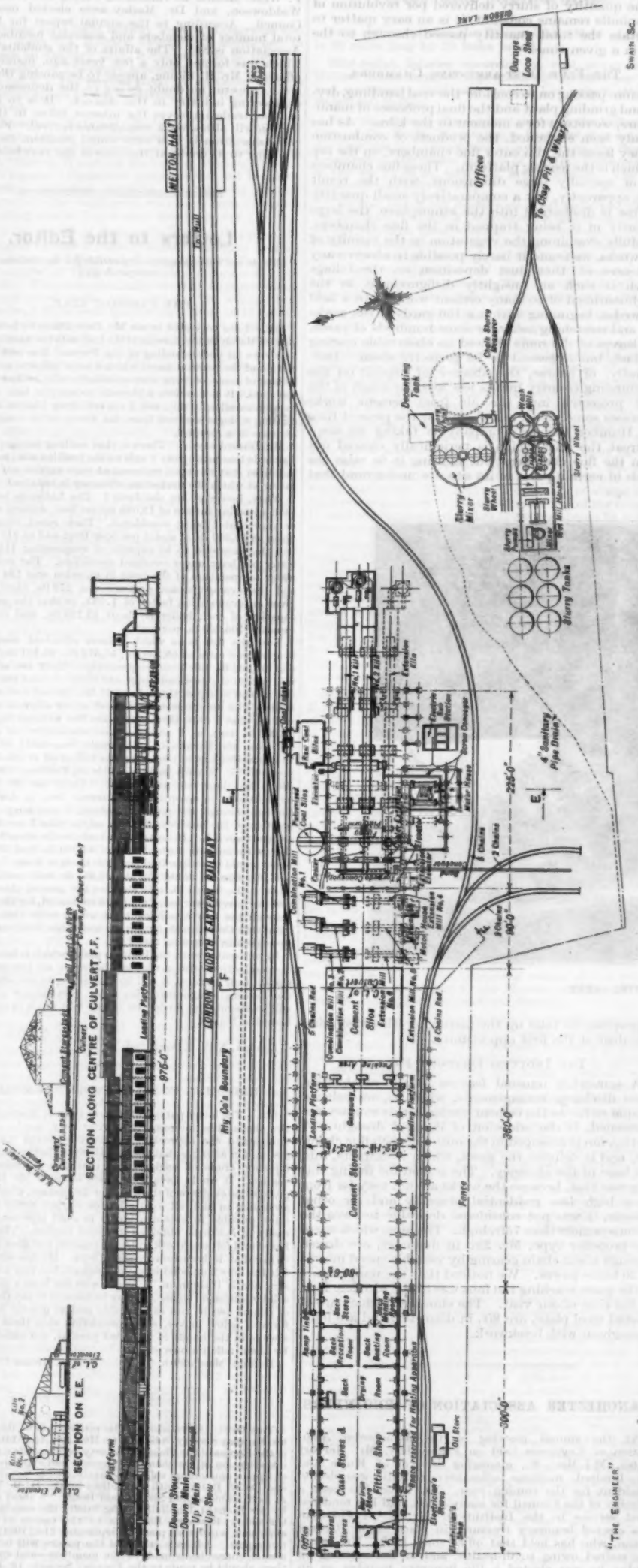
FLOW SHEET

FIG. 10—CEMENT SLURRY PUMPS

After passing through the straining gratings of the

* No. I. appeared March 28th.

PLAN AND SECTIONS OF THE WORKS OF THE HUMBER PORTLAND CEMENT COMPANY, LTD.



wash mills the slurry flows into the sump of another lifting wheel, the discharge from which is into either of two reinforced concrete triple mixers. Each of the latter measures 40ft. long by 20ft. wide by 10ft. deep, and each is provided with three sets of revolving stirring arms driven in similar manner to, but at a much slower rate than those in the wash mills, by a 20 horse-power motor. The two mixers are designed to hold about a full day's supply of slurry, for it is intended that, under normal circumstances, whereas the grinding plant to which we are about to refer will operate continually day and night, the wash mills will only be worked in the day time. It is from the mixers that samples are being continually taken by the works chemists for analysis, and in them, too, any adjustments in the proportion of the ingredients which may be found necessary are made, the requisite arrangements for the purpose being provided.

The Slurry-grinding Tube Mills.

From a sump connected to both mixers, but separated from them by valves so that the supply may be from one or other or both mixers as desired, the slurry is lifted by another wheel to shoots leading to two Edgar Allen "Stag" tube mills—see Supplement—with the construction of which our readers are familiar. They each measure 20ft. by 5ft. in diameter, and they are each driven through gearing by a 75 horse-power motor. In them the slurry is so finely ground that, when dried and pulverised, 95 per cent. of it will pass through a standard testing sieve having 180 holes to the lineal inch. The discharge from the tube mills is into a small receiving tank which is furnished with motor-driven stirring arms, and which forms the sump of the slurry pumps—Fig. 10. Of the latter there are three, all of them being driven through gearing by one 50 horse-power motor, and each being of the vertical three-throw ram type with rams 10¾in. in diameter by 15in. stroke. One of these pumps delivers slurry to the feeding platform of the rotary kilns; another can lift and discharge it into a set of air-mixing storage silos situated near by, while the pipe connections of the third are such that it can perform either of these duties so that it acts as a stand-by for both the other sets.

The Slurry Storage Silos.

The provision of a large storage of prepared slurry ready to be fed into the kilns is nowadays looked upon as a necessity. It not only aids the chemist in getting his mixture correct, but it makes it certain that the feed to the kilns is not curtailed even though there should be a breakdown of the grinding and mixing plant, or the stoppage of the supplies of raw material by reason of bad weather or from other causes. The storage capacity provided at the works of the Humber Company is sufficient to make about 1600 tons of clinker, or enough to keep both kilns in operation for about 4½ days. The equipment comprises six large riveted steel tanks or silos, each 50ft. high from ground level and 23ft. in diameter—see Supplement. The tanks are on concrete bases in two lines of three each, in a position adjacent to the pump house. It is not, of course, possible to store mixed slurry in a tank or other receptacle without keeping it agitated. The slurry in the silos under consideration is kept agitated by means of compressed air, a method of stirring up cement slurry which has been adopted to a considerable extent in modern plants on the Continent, though the number of installations in this country in which the method has been adopted is comparatively small. Many advantages are claimed for it, especially in connection with medium sized and large factories. For example, it does away with large horizontal mixing tanks containing mechanically-driven stirrers, which take up a lot of room, are costly to build and entail an appreciable amount of expense in repairs. Air mixing is, furthermore, claimed to result in a valuable saving of power, for, whereas it is necessary to keep the stirring arms of mechanically-operated mixing tanks almost continuously at work night and day, it is sufficient for an air mixing tank to be blown for short periods at intervals. The pressure air for the Humber Company's silos is obtained by means of a motor-driven air compressor supplied by Broom and Wade, of High Wycombe, the pressure employed being about 25 lb. per square inch, and the horse-power of the motor 50. The plant is housed in the building which contains the slurry pumps, and where, it may be added, is also the pump employed for lifting the well water to the chalk quarry.

The Rotary Kilns.

When the works are fully equipped as designed there will be three rotary kilns, but, at the moment, only two are in position. Each of them is 200ft. long and 9ft. in diameter, and it is noteworthy that they are parallel from end to end and are not enlarged in diameter in the region of the clinkering zone. At the time when kilns with enlarged firing zones were introduced, it was claimed for them that they possessed many advantages over kilns of the same diameter from end to end, but there are many who assert that any advantages which they may possess are more than counterbalanced by disadvantages. It is to be presumed that Messrs. Maxted and Knott share this opinion; it is, at any rate, certain that

Edgar Allen and Co., while they are prepared to, and actually do, manufacture both types of kiln, express a decided preference for the parallel kiln except under special circumstances. It is, moreover, generally admitted that, from the point of view of mechanical design, the parallel kiln has much to recommend it, and that an enlarged zone presents difficulties in the fixing and upkeep of the firebrick lining. This by the way; the fact remains that the kilns under consideration are of the parallel type. The external tube is in each case composed of twenty rings of heavy-rolled steel plates riveted together, and it is carried on four heavy cast steel tires—one near each end and the others equally spaced between them—each tire being supported on two steel rollers, which latter are mounted on forged steel spindles running in adjustable gun-metal bearings. Following accepted custom these tires are not riveted or bolted to the shell, but are supported on cast steel chairs—themselves riveted to the shell—in such a way as to allow the kiln to expand or warp slightly without distorting them, the insides of the tires being machined so as to fit loosely on the chairs. Each kiln is also provided, near the third tire from the firing end, with a large toothed wheel which is attached to the shell by means of tangential steel plates, so as to give flexibility and to allow for expansion and distortion. The kiln is driven by means of a variable speed "cascade" 50–70 horse-power motor through a train of machine-cut steel reduction gearing, the pinion on the final spindle of which meshes with the toothed driving wheel attached to the shell—Fig. 11. The controllers for starting and varying the speed of the kilns are arranged on the firing platform. At the time of our visit the kilns were revolving at the rate of one turn in about 2½ minutes, the output of clinker from the two averaging at the time rather over 14 tons per hour. The firing hood is of Messrs. Edgar Allen's standard portable type, and is furnished with the usual firing nozzle, clinker discharge connections, &c. The inclination of the kilns is 1 in 20, and the lining employed on the hotter portions is made of "Adamantine" bricks supplied by C. Davison and Co., Limited, of Chester. Various views of the kilns are given in our Supplement.

FIG. 11—KILN DRIVING GEAR

The Slurry Feeding Mechanism.

The method of feeding the slurry into the kilns is as follows:—The slurry is pumped up to a covered platform constructed above the tops of the flue chambers at the upper end of each kiln, the lift from pump floor level being about 45ft. The pumps are arranged always to raise more slurry than is actually required, and they deliver at present into two automatic feed tanks in which the level of the liquid is always maintained constant, the excess slurry flowing back to the storage plant. In each automatic feeding tank is a horizontal revolving spindle, driven by a motor, the speed of which can be controlled from the firing platform. The spindle is fitted with four equally-spaced hollow arms, the outer ends of which are of scoop form. As the level of the slurry in the feed tank is kept constant, as just explained, the scoops, which dip a certain distance below the level of the slurry, pick up a fixed quantity at each revolution and deliver it into a trough, which discharges into the feed spout leading into the top of the rotary kiln. It is clear, therefore, that since the operator has control of the motors he can very accurately gauge the quantity of slurry being fed into the kiln to meet any variations in the firing or other conditions. We may add that there is also a tell-tale device on the firing platform so that it is always known whether the feeding arrangements are operating satisfactorily or not. Each automatic device has an arm fitted to its spindle which actuates a revolution counter, so that as the quantity of slurry delivered per revolution of the spindle remains constant, it is an easy matter to ascertain the total quantity passed through to the kiln in a given time.

The Flue Dust-arresting Chambers.

Before passing on to consider the coal handling, drying and grinding plant and the final processes of manufacture, we return for a moment to the kilns. As has already been explained, the products of combustion as they leave the kiln enter flue chambers, on the top of which is the feeding platform. These flue chambers are of specially large dimensions, with the result that, apparently, but a comparatively small quantity of dust is discharged into the atmosphere, the large majority of it being trapped in the flue chambers. Carefully examining the vegetation in the vicinity of the works, we found it barely possible to observe any evidences of that dust deposition on the foliage which is such an unsightly disfigurement in the neighbourhood of so many cement works. In a field of swedes, beginning within a 100 yards of the works site and stretching away for some hundreds of yards, the leaves of the roots showed no observable coating of dust, but appeared to be perfectly clean. Incidentally, of course, the absence of deposit on the surrounding country means less loss, for much of the dust projected into the air from cement works possesses some value, and though at the present time the Humber Cement Company is taking no steps to treat the dust which is periodically cleared out from the flue chambers, but is using it to raise the levels of certain parts of its site, we understand that it proposes to take up the matter of otherwise using this dust at the first opportunity.

The Induced Draught Fans.

A somewhat unusual feature of the combustion gases discharge arrangements, which is, we believe, unique so far as the cement works in this country are concerned, is the adoption of induced draught. A suction fan is arranged in the outlet of each flue chamber, and it delivers the gases, which it extracts, into the base of the chimney. The reason for taking this step was that, because the works are not very far from some high-class residential property and for other reasons, it was not considered desirable to have the chimneys more than 75ft. high. The fans, which are of the propeller type, 5ft. 2in. in diameter, are driven through silent chain gearing by variable speed motors of 30 horse-power. We noticed that the temperature of the gases reaching the fans was about 615 deg. Fah. at the time of our visit. The chimneys, which are of riveted steel plate, are 8ft. in diameter, and are lined throughout with brickwork.

MANCHESTER ASSOCIATION OF ENGINEERS.

At the annual meeting of the Manchester Association of Engineers held on Friday last, Mr. Herbert Bates, M.I.Mech.E., managing director of Hulse and Co., Limited, machine toolmakers, Salford, was elected president for the coming year. Mr. Bates has been a member of the Council for many years, and has rendered good service to the Institution. Mr. E. J. Christian was elected honorary treasurer in place of Mr. George Saxon, who has held that office since 1909. Mr. Saxon has retired owing to ill-health, and at the meeting on Friday he was elected a life honorary member as an appreciation of the services he has rendered to the Association. The trustees elected are Messrs. E. G. Constantine, W. Fox. A. Saxon, J. H. Stubbs, and Alderman F. West. Messrs. D. Adamson, Curtis, F. Walker, E. P. Widdowson, and Dr. Morley were elected members of Council. According to the annual report for 1923, the total number of members and associate members of the Association is 844. The affairs of the students' section, which was formed only a few years ago, mainly by the efforts of Mr. H. Pilling, appear to be causing the Council some concern, no doubt owing to the depression in the engineering industry in this district. It is to be hoped that as trade improves the interest taken in the junior section will also show a considerable revival. Financially the Association is in a very sound position, the balance standing to its credit at the close of the year being £6351.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE PARSONS' LINE.

SIR,—I am very glad to see Mr. John Blizard's letter in your issue of March 28th in defence of the Lakeside test results, because he shows an understanding of the Parsons' line and an appreciation of the point at issue, which I have failed to notice in the letters of some of your correspondents who rushed to defend the tests. It is therefore a pleasure to reply to him. His argument is excellently put, and I am not doing him an injustice in quoting a single sentence from his letter, as it really contains his case in a nutshell.

Mr. Blizard says: "There is thus nothing strange about the Lakeside line cutting the x axis on the positive side, for it simply indicates that the tests represented were carried out above the rating at which the maximum efficiency is obtained."

What, however, are the facts? The Lakeside boilers have each a heating surface of 13,060 square feet, without economiser or superheater being considered. Their rated evaporation is given as 90,000 lb. of steam per hour from and at 212 deg. Fah., and they are said to be capable of evaporating 115,000 lb. of water per hour under overload conditions. The average feed-water temperature of the tests in question was 184 deg. Fah., and the average steam pressure was 279 lb. absolute. This gives an evaporation factor of 1.083, so that the actual rated capacity of each boiler is about 83,100 lb., and its overload capacity 106,200 lb. per hour.

Now the five tests which I have criticised were made at evaporation rates of 53,390 lb., 57,572 lb., 81,121 lb., 83,950 lb., and 92,302 lb. per hour respectively. They are all therefore well within the overload range and three of them are well below the normal rating of the boiler. If Mr. Blizard and any of your readers who are interested will look at my diagram again, they will see that I drew the evaporation line without regard to the 92,202 lb. test, as I wished to be absolutely fair and above criticism, and I realised that it might reasonably be contended that the efficiency of the boiler was falling off at this load. You yourself, Sir, in your leading article on February 15th, noticed that I had done this, and wrote: "There can also be little or no hesitation in accepting the Parsons' line, as drawn by Mr. Napier, through the points. Indeed, if anything, noting the position of the last dot, the line might have been drawn even steeper than it is. In any case, it leads to the absurd conclusion that with no coal burnt between 40,000 lb. and 50,000 lb. of water would be evaporated per shift of eight hours."

If Mr. Blizard would like the 83,953 lb. test omitted as well, or even the 81,121 lb. test also, on the ground that the boiler was too heavily worked, I am quite contented, for the line drawn through the two remaining tests would more than prove my point that the Lakeside figures are unreliable, however much care was taken in obtaining them.

In connection with the Lopulco plant, which is being installed in conjunction with a Clayton boiler at an important power station near London, it will be interesting to see whether or no the Parsons' evaporation line holds, particularly as the boiler will be operated at duties per square foot much in excess of the Lakeside boilers.

F. D. NAPIER, M.I.E.E.

London, N.W. 2, April 2nd.

KNOCKING IN SOLID INJECTION ENGINES.

SIR,—The letter published in your issue of March 28th having the above title interests the writer very much. Those who understand can appreciate the motive behind the letter. It assumes in advance that there is always a heavy knock on solid injection crude oil engines, and that this is absent in Diesel engines. It would have been much better if Mr. Raphael had given some evidence of the knock or detonation, which evidently, according to him, all solid injection engines suffer from. It is quite possible to obtain a knock in solid injection engines as easily as it can be obtained in Diesel engines. The writer has heard and felt the knock in Diesel engines, but does not presume to say that it is customary with them. He has also heard and felt the knock on solid injection engines, but it is neither necessary nor is it common. As one who has been a pioneer in the solid injection oil engine, he may be allowed to say that that type of engine can be run as smoothly and as quietly as any other form of prime mover, and, considering that these engines are always in the hands of unskilled persons, the success obtained by them tells its own story.

Halifax, March 29th. HUGH CAMPBELL.

THE OPPAU EXPLOSION.—The programme of the meeting of the Faraday Society to be held on Monday, April 14th, at 8 p.m. in the Rooms of the Chemical Society, will include a report on an investigation of the chemical, physical and explosive properties of Oppau ammonium sulphate-nitrate, by Sir Robert Robertson and Dr. G. Rotter, with appendices by Dr. H. H. Thomas, Mr. A. L. Hallimond and Sir William Bragg. A short introduction by Sir Richard Threlfall, giving briefly the conclusions of the Chemistry Research Board as to the causes of the Oppau explosion, which took place on September 21st, 1921, will precede the report. Advance copies of the papers will be available—a small charge being made to non-members—and application for them should be made to the Faraday Society, 10, Essex-street, Strand, W.C. 2.

Railway Matters.

THE scheme for a light railway between Longridge and Hellifield, along the Hodder Valley, last mentioned in this column on January 25th, is evidently to go through, as the Ministry of Transport announces that it has made an Order for it. The powers given by an Order in 1909 for the construction of the Merrivale Light Railway have been revived.

THE Canadian National Railways have completed arrangements for the establishment of a chain of seven wireless broadcasting stations across Canada, namely, at Montreal, Ottawa, Winnipeg, Saskatoon, Regina, Edmonton and Calgary. Broadcast programmes will be given twice weekly, including concerts and talks by officials of the system to the employees, who have been furnished with receiving sets at 20 per cent. less than cost.

DURING the month of January last the railways of the United States carried a slightly higher tonnage—judging by the number of fully loaded cars—than in the corresponding month of 1923, but the receipts were 6.7 per cent. lower. This reduction suggests that a greater quantity of lower-rated traffic was carried. The expenditure was, however, 5.9 per cent. less, owing mainly to 12 million dollars less being spent on the maintenance of equipment. This feature indicates that the rolling stock is getting into better order.

IN reviewing, in our issue of March 14th, the report for 1922–23 of the Indian Railway Administration, we quoted therefrom the intimation that the State was taking over the East Indian and Great Indian Peninsula railways, when their contracts expire on December 31st, 1924, and June 30th, 1925, respectively. To this announcement there may be added the further recent one by the Under-Secretary of State for India that "this does not preclude the possibility of the subsequent transfer of the management of one of the railways to an Indian company."

IN this column of our issue of January 12th, 1923, reference was made to an agitation by the railwaymen of Victoria for the establishment of a Government Department to hold inquiries into railway accidents. The trouble is that whilst accidents are inquired into as a matter of course, the inquiries are held behind closed doors, and the public imagines that the Railway Department has something to conceal. The situation is difficult because the railways belong to the Government, and any more formal inquiries would mean that one Department was investigating the administration of another.

ANSWERING a question, Mr. Gosling, the Minister of Transport, said on the 24th ult. that he was informed by the railway company that the electrification of the suburban lines of the South-Eastern section of the Southern Railway is proceeding with all possible speed, and that 68 miles of conductor rails have already been fixed, and that the rails on the North Kent line will be begun to be laid in about two months' time. The company also states that thirty-three men from the Woolwich area had already been engaged on electrification works, and that it was anticipated that a further twenty would be required in that area shortly.

THE situation as to the electrification of the London and North-Eastern Railway in the Great Northern area and as to a tube northwards from Finsbury Park, was explained in the House of Commons, when the company's Bill was given a second reading. The Bill was given a second reading after an assurance by Mr. Murrough Wilson, one of the directors, that if, by October next, the company had failed to redeem its promise, any provision—statutory or otherwise—under which the company's consent was necessary for the construction of a railway northwards from Finsbury Park by any other company, body or persons, would be waived.

THE retirement on March 31st of Mr. C. W. Neele, the electrical engineer of the Great Central section of the London and North-Eastern Railway, is announced. Mr. Neele began his railway career on the London and North-Western Railway, of which his father, the late Mr. G. P. Neele, was the superintendent of the line for over thirty years. On the death of Mr. R. Stuart Hampson, in 1898, Mr. Neele was appointed electrical engineer to the Great Central Railway. Mr. A. F. Rock, the electrical engineer of the former North Staffordshire Railway and the *doyen* of railway telegraph engineers, has, after fifty-three years' service with that company, also retired.

ON March 25th, Mr. Graham, the Minister for Railways, introduced in the Dominion House of Commons legislation providing for the construction of twenty-six branch lines of the Canadian National Railways, covering a three-year programme. The cost is estimated at approximately 27 million dollars. Most of the new branches are to be built in the Prairie Provinces to feed the main line. They are the same as the Government asked for last year, but at that time the empowering "omnibus" Bill was not passed by the Senate. This year the construction of each branch line is provided for by a separate Bill, and it is probable that the majority of the branches planned will be authorised by both Houses. These developments will be of great benefit to settlers who are now from 8 to 20 miles away from railway facilities, and they will stimulate further the opening up of the prairies by incoming settlers.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the year 1923 was as follows, the corresponding figures for 1922 and 1921 being added in brackets:—Locomotives, £2,893,626 (£5,074,843, £7,936,903); rails, £2,560,766 (£2,445,710, £3,097,123); carriages, £987,321 (£2,020,814, £1,549,259); wagons, £3,167,374 (£3,347,310, £6,026,509); wheels and axles, £984,449 (£1,194,397, £1,722,746); tires and axles, £697,767 (£417,077, £1,205,247); chairs and metal sleepers, £950,553 (£2,015,977, £1,522,320); miscellaneous permanent way, £1,305,375 (£1,388,974, £2,654,684); total permanent way, £6,807,256 (£7,655,508, £10,557,529). The weight of the rails exported was 287,534 tons (253,680 tons, 177,101 tons), and of the chairs and metal sleepers, 82,404 tons (143,911 tons, 68,521 tons). During the month of December, 1923, locomotives to the value of £192,871 were shipped to India, and rails of the value of £68,299 were shipped to New Zealand, of £55,533 to India and of £50,788 to South Africa.

Notes and Memoranda.

IT is estimated that the Wainwright oilfield of Canada is 50 miles long by 20 miles broad.

NON-FATAL injuries occurring at coal mines in the United States number approximately 200,000 per year, and represent a total coal tonnage loss valued at about 39,000,000 dollars.

FOR the purposes of a geodetic survey in the Yellowhead Pass of the Rocky Mountains, a base line was required. As there was no level country to lay it out on, the base was measured on the frozen surface of a lake. Posts were set in the ice at 50 m. intervals, and frozen in. The base measured was 5800 m. long.

THE first test of the Brasher air breakwater was carried out, according to the *S.A. Mining and Engineering Journal*, on the southern breakwater at Port Elizabeth. The air broke the surface waves and produced smoothness in the space enclosed by the air pipes. The ground swell, however, had no appearance of material diminution. The test was not exactly a success. A new method of laying the air pipes is to be tried, and a further test carried out.

AMONG the subjects dealt with at a meeting of the National Winding and General Engineers' Society, held recently in Sheffield, there were the need of Government engineering inspectors, improved ventilation in the engine-room, more adequate brake power, adoption of a more reliable visual signal system, need for steam reversers on all winding engines of whatever capacity, and the covering of the brake face to prevent grease getting thereon.

AN unusual fatal accident happened recently in Birmingham, when a piece of steel tube, about 10ft. long, shot out of an annealing furnace and went right through the body of the attendant. The tube was an old boiler tube, and it was assumed that it was choked with scale, which was moist. The heat of the furnace produced sufficient steam pressure to project the tube out of the furnace. It has been recommended that the tubes should be rodded before annealing.

THE two colliery chimneys in the neighbourhood of the Douglas Bank Collieries at Wigan, which had been prominent landmarks in the Wigan coalfield for sixty years, were, according to the *Iron and Coal Trades Review*, demolished on March 22nd. The Douglas Bank Collieries, owned by the Rosebridge and Douglas Bank Colliery Company, Limited, were worked by means of the North Pit and the South Pit, and at one time employed over 2000 men, but at the end of 1920 the mines were closed down, and dismantling operations have been in progress ever since.

ACCORDING to a Customs statement forwarded by H.M. Trade Commissioner at Sydney, the value of imports of German origin into New South Wales during the month of December last was £49,329, as compared with £49,735 in November and £33,491 in October. The principal articles imported, according to their value, included upright pianos, £8463; toys, £3672; musical instruments, £3043; Diesel engines, £2142; presses, punching and shearing machines, £2060; clocks, £1829; cutlery, spoons, and forks, £1363; laces for attire, &c., £1084; grand pianos, £1040; and domestic glassware, £1019.

COALOWNERS in Illinois have requested that the American Bureau of Mines should study the problem of reducing the proportion of screenings in the coal mined in that State, a problem which is said to have become quite acute. The market for the Illinois product is largely one for house coal, and the demand therefore is for the larger sizes. This problem of screens has been growing more intense since the plan of paying the miners for "run-of-mine" tonnage rather than for "screen-coal" tonnage came into existence. While there are other factors involved, one of the most important causes of this excess of screenings, according to the Bureau of Mines, is the method employed in the use of explosives.

A HYDRO-ELECTRIC installation is nearly completed for the International Paper Company at Glens Falls on the Hudson River., The ultimate capacity is 50,000 horse-power, the normal head being 66ft. At present ten 6000 horse-power units are being installed, each requiring 1520 cubic feet per second. The voltage will be stepped up to 66,000. The main dam is 551ft. long and has a maximum height of 70ft. It is built of reinforced concrete. A particular feature of the installation is that every part is built on sand and gravel foundations, the area even being largely under-lain with quicksand. The foundation area of the power-house is divided into 10 boxed sections by driving sheet steel piling to 25ft. below sub-grade. These sections act as sand columns to transmit the load to a safe depth. To prevent the material from squeezing out in front of the foundation the reinforced concrete tail-race apron has been extended out about 50ft. from the power-house to where gravel was found in the river bed, and heavy concrete buttresses are carried out from this apron to the sides of the power-house foundation.

IN the course of experiments designed to perfect methods for the establishment of wireless communication between persons entombed in mine disasters and rescue workers on the surface, conducted by the United States Department of the Interior at the experimental coal mine of the Bureau of Mines, near Pittsburg, Pa., signals have been transmitted obliquely through a distance of 800ft. of rock by the use of the T.P.S. or ground conduction system, developed by the Army Signal Corps. Signals were also transmitted with little difficulty by using compressed air piping, car rails and other similar conductors. The intervention of such poor conductors as water, coal and mud, and the substitution of wooden for steel rails, did not prevent the transmission of signals. The T.P.S. method of ground telegraphy is a means of communication which requires no wire connection between the sending and receiving stations. It differs from radio telegraphy in that the transfer of electrical energy from the transmitting to the receiving apparatus takes place mainly by conduction and, to a much less extent, induction through the ground, instead of through the air. The T.P.S. method of signalling is for telegraphy only, and cannot be used for voice or speech transmission.

Miscellanea.

THE old wooden battleship Revenge, one of the last to be built at Appledore, has been taken from the Clyde to Appledore for breaking up.

THE new ferry landing and docks, which are to be constructed at Middlesbrough, are to cost over £28,200 and be completed by February, 1925.

A CONTRACT for the equipment of the port of Beira, East Africa, with deep-sea wharves and quays has, it is announced, been approved by the Government at Lisbon.

THE Home Secretary has appointed a committee to inquire into the working of the provisions of the Factory and Workshop Acts for the medical examination of young persons as to their fitness for employment in factories.

THE Polish Parliamentary Commission for Foreign Affairs has asked the Government to reserve a part of the vote for expenses to be incurred at Danzig in order to help towards the construction of a new Polish port at Gdynia.

THE new sewerage scheme at St. Just (Cornwall), which has cost £4500, is nearly completed. Considerable difficulty was met with, a pipe track having to be cut through masses of rock at the base of the cliffs where the outfall is situated, and provision had to be made for the protection of the pipe line from the heavy seas which break over it daily.

THE British Electrical and Allied Manufacturers' Association directs attention to the fact that, in furtherance of technical education, it grants annually, to properly qualified candidates of British birth engaged in engineering works, ten scholarships, each of the value of £100, in addition to the payment of college fees. The last date for receipt of applications is June 1st.

IN the course of a recent lecture at the Royal Society of Arts, on the progress of Sarawak, Borneo, the Hon. T. G. Cochrane stated that since the development of the oil resources of the district the village of Miri, which in 1909 had a population of eighty natives all told, had grown into a town possessing railways, electric lighting, and an automatic telephone exchange far in advance of anything provided by the Post Office in London.

OVER 2,000,000 tons of Alberta coal were sold to Canadian points outside the province and to the United States during 1923. The total production of coal for the year was 6,866,924 tons, 1,382,788 being sold for consumption in Alberta, 1,937,753 sold to other provinces, and 83,557 tons sold to the United States, while 3,110,121 tons were sold to the railway companies. Compared with the previous year, 1923 shows an increase in production of 890,491 tons.

HIS ROYAL HIGHNESS PRINCE ARTHUR OF CONNAUGHT will be the principal guest at the official banquet of the Empire Mining and Metallurgical Congress. The banquet will be held at the Guildhall, by the courtesy of the City Corporation, on Thursday, June 5th. The Lord Mayor and other distinguished guests will also be present, including official delegates from all parts of the Empire. The sessions of the Congress will be held at the British Empire Exhibition from June 3rd to 6th inclusive.

WE are pleased to learn that a Guide Lecturer has been appointed to expound to the public the engineering exhibits at the Science Museum. Eng. Captain E. C. Smith, O.B.E., R.N., who is well versed in such knowledge, has accepted the post and has already begun his duties. An interesting promotion in the museum is that of Mr. H. W. Dickinson to be a keeper; he is well known to many of our readers as the energetic hon. secretary of the Newcomen Society, and has been connected with the museum for many years as a deputy-keeper.

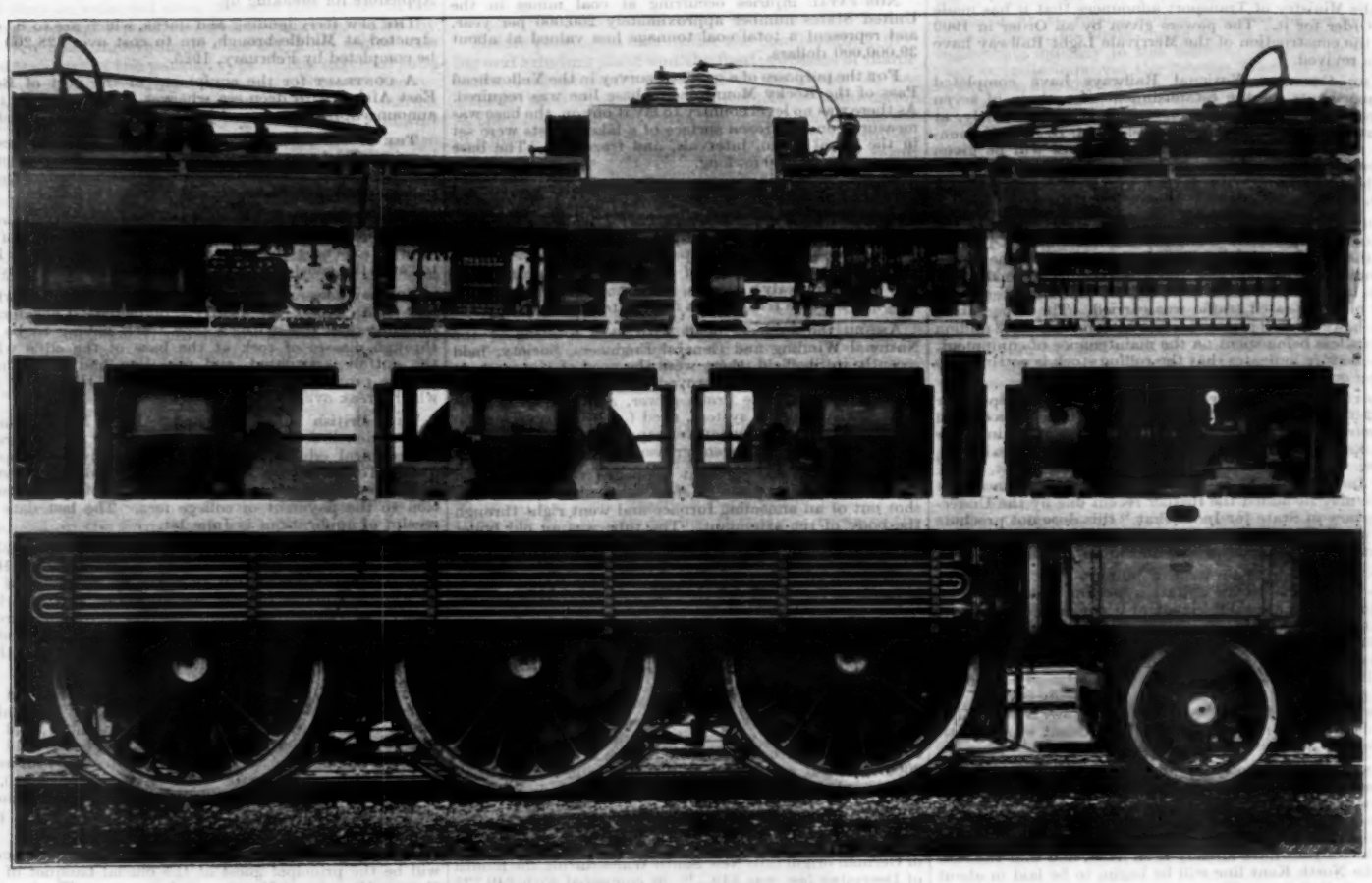
CONSIDERABLE interest has been created, says the *Iron and Coal Trades Review*, by the reported discovery of a seam of coal during well-boring operations at Burnham-on-Crouch. It will be remembered that during well boring at Ruxwell, near Chelmsford, shortly before the war, coal was found about 300ft. below the surface, and from time to time similar discoveries have been made in different parts of the district. The present find is stated to be from 4ft. to 6ft. thick, and is at a depth of 420ft. The coal is, however, of inferior quality, and it is considered it could not be worked at a profit.

IT is officially announced that the Royal Automobile Club's small car trials will this year take place between May 12th and 17th, and that Llandrindod Wells will be the point from which they will start. The regulations provide for six runs of about 160 miles each, and Llandrindod Wells will be able to supply some interesting trials ground within that radius. The routes have been chosen with the object of giving a really severe test to the cars entered, while avoiding freak hills. Every portion of the routes has, it is stated, been covered by a car typical of those which are being entered in the trials, and the fact that the routes have been covered in this manner is an indication that the routes are not beyond the measure of the small car.

IT is announced by the Cunard Company that Mr. G. McL. Paterson has been appointed to the position of naval architect, rendered vacant by the death of Mr. Leonard Peskett. Mr. Paterson was educated at Cheltenham College, afterwards proceeding to Pembroke College, Cambridge, where he took his B.A. degree in Mechanical Sciences Tripos. In 1912 he joined the firm of John Brown and Co., Limited, Clydebank, going through the various technical departments, including experimental tank, design and Admiralty drawing-office. He became associated with the Department of the Director of Naval Construction at the Admiralty in 1915, and was principally concerned with the development of aircraft-carrying vessels, from seaplane carriers, evolved from cross-Channel steamers, to the Hermes, which was the first aircraft carrier designed as such. In May, 1919, Mr. Paterson joined the Cunard Company, being attached to the technical side of the naval architect's department. He was also closely associated with the late Mr. Peskett in the development of the company's post-war building programme.

2-C-1 SINGLE-PHASE ELECTRIC LOCOMOTIVE WITH INDIVIDUAL DRIVE

(*For description see page 369*)



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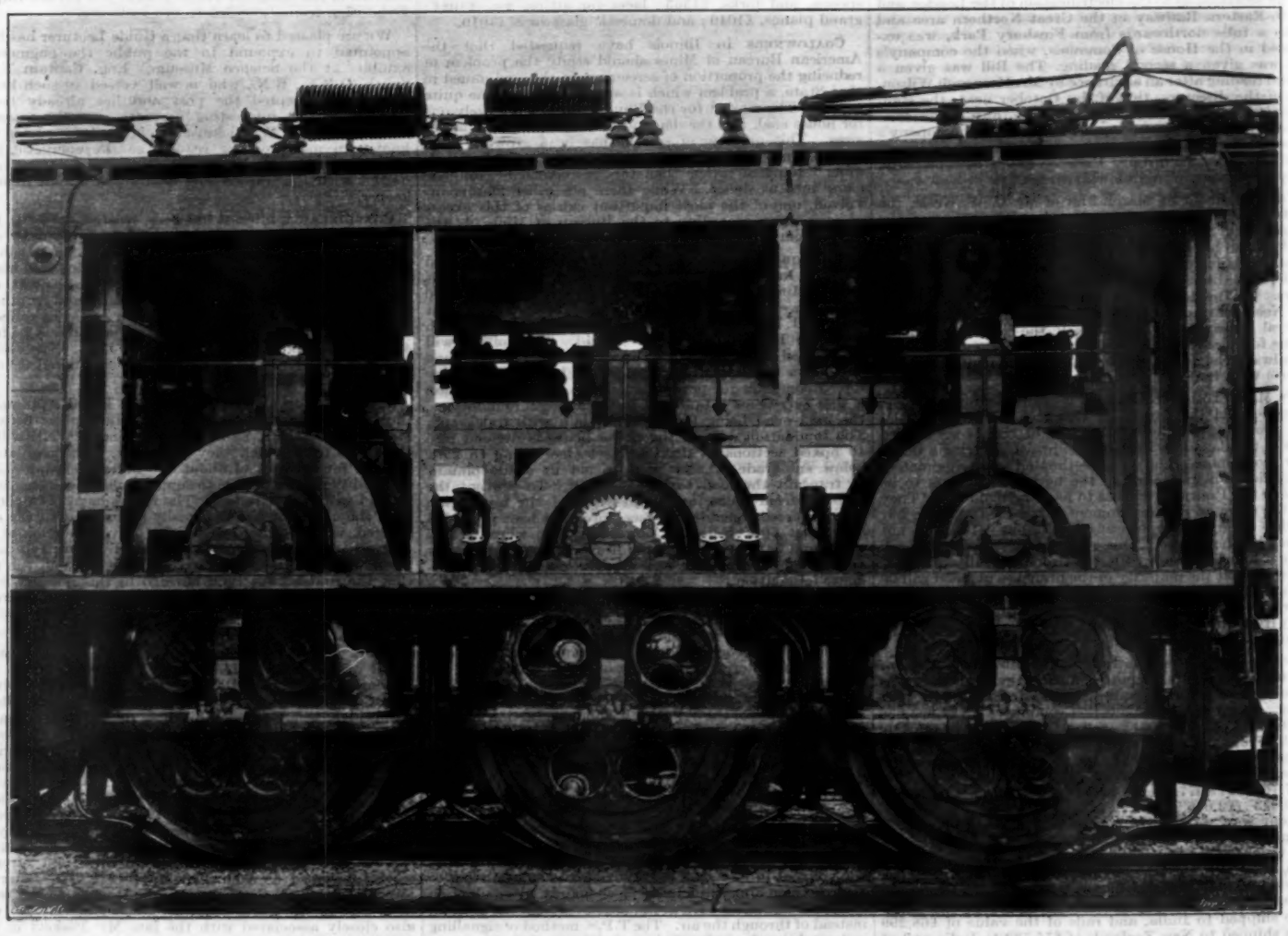

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TWO-PAGE SUPPLEMENT—THE WORKS OF THE HUMBER PORTLAND CEMENT COMPANY, LIMITED.

DEATH.

ON March 31st, at 176, Ashley-gardens, Westminster, ARTHUR FREDERICK PHILLIPS, M. Inst. C.E., late of 82, Victoria-street, London, S.W. 1, aged 81.

THE ENGINEER.

APRIL 4, 1924.

The Thermal Action of Cutting Tools.

IN our last issue we had occasion to deal with the effect of elevated temperatures on the ultimate strength, yield point and fatigue limit of metals, with particular reference to the consequences of such effect in high-pressure, high-temperature steam boilers and prime movers. To-day we return to the subject, but from an entirely different point of view. Since we last wrote, Mr. Dempster Smith and Mr. Hey have presented an important paper on the cutting properties of lathe tools before the Manchester Association of Engineers, of which paper an abstract is given in this issue. Using a standard lathe, an ordinary tool and a bar of plain mild steel, they have found that, taking light cuts, the amount of metal removed before the tool reaches a standard degree of bluntness follows other than a simple law. As the cutting speed is increased, the durability of the tool—measured by the aforesaid amount of metal removed—increases to a maximum, falls thereafter to a minimum, rises to a second maximum, and again falls. Fifteen years ago Mr. E. G. Herbert reported the existence of the same phenomenon, but the "Herbert humps," as they were irreverently called, were scoffed at or where set down as an effect of the exceptional means and methods employed by Mr. Herbert in his experiments. Mr. Smith and Mr. Hey have now shown that exactly the same "humping" of the durability curve occurs under conditions and with appliances strictly comparable with those of the workshop, and, having established the existence of the phenomenon as an actual fact, have sought to explain it. Basing their opinion on the well-known modifying effect which elevated temperatures have upon the ultimate strength, elastic limit and hardness of metals, they advance the view that the variations shown by the durability curve result from the temperatures reached by the tool and work under the cutting action and the modifications of the physical properties which such temperatures produce in the metals of the tool and the work jointly. They do not commit themselves as to which property or combination of properties lies at the root of the matter, but Mr. Herbert has adduced experimental evidence which seems strongly to point towards the work-hardening tendency or capacity as being the determining factor.

In our issue of March 7th we described and discussed Mr. Herbert's investigations into the work-hardening tendency of cold metals by means of a modified application of his "pendulum" hardness tester. Elsewhere in this issue we publish an article by him dealing with the work-hardening tendency of metals at elevated temperatures. Testing a piece of the actual steel used by Mr. Smith and Mr. Hey, in their experiments, he found that the work-hardening tendency, represented by a figure of nearly 50 at room temperature, fell very rapidly in the neighbourhood of 100 deg. Cent., reached a minimum of about 12 at 112 deg. Cent., and thereafter rapidly rose again to and above its original value. It is important to make it quite clear that the elevation of the temperature did not affect the *hardness* of the metal. That property, as it would be judged by the Brinell test or the substantially equivalent pendulum "time" test, remained practically constant up to 200 deg. Cent. The change which was observed occurred in that property, or congeries of properties, which determines the tendency of the metal to harden as a result of being worked. Correlating his own and Messrs. Smith and Hey's results, Mr. Herbert has drawn the conclusion that the first hump in the durability curve implies the attainment by the work of the temperature at which the metal being cut exhibits its minimum work-hardening tendency. It may perhaps be thought that a cutting speed of 60ft. per minute is too low to generate a temperature in excess of the boiling-point of water. Against such criticism, it may be replied that we have really very little knowledge concerning the temperatures produced during the cutting of metals. A uniformly blued chip is evidence to the effect that the metal of the chip has reached a temperature of 330 deg. Cent. or thereabouts. A tool running dull red is at a temperature of from 500 deg. to 700 deg. Cent. But there is no visible indication of the temperature reached by the work at the cutting surface. That surface is small, and is constantly changing its position. It may well be the case that the cutting surface momentarily reaches quite a high temperature, the small area or volume affected and the rapid conduction of the heat into the rest of the work preventing the ready recognition of the fact. Until we receive some fairly precise information as to the temperature momentarily reached by the work immediately under the cutting edge of the tool, we can only accept Mr. Herbert's explanation of the first maximum in the durability curve with reserve, for lacking evidence on this point, it is—or so it appears to us—possible that the acquirement by the work-metal of its minimum work-hardening tendency is indicated by the second, and not the first hump in the durability curve. Mr. Herbert, it will be found, attributes the second maximum to a change in the metal of the tool, but what such change consists of he is not as yet prepared to say. As for a third hump in the durability curve, which Messrs. Smith and Hey have detected in a few instances, Mr. Herbert frankly confesses his embarrassment. We may well leave the third hump out of discussion until we have settled the true significance of the first and second. It may be suggested that attention should be given to the first minimum as well. It is just possible that it marks the attainment by the tool of *its* minimum work-hardening tendency, and that but for this factor the durability curve would continue smoothly to the so-called second hump, marking the attainment by the work-metal of its minimum hardening tendency. Mr. Herbert, it will be observed, has examined the hardening tendency of annealed high-speed tungsten steel, and finds that the minimum occurs at about 150 deg. Cent. At first sight the fact that this temperature is higher than the corresponding temperature for the work-metal seems to form an obstacle to the alternative view we have advanced as to the meaning of the durability curve. But it appears to be certain that the tool is always hotter than the work, and so far as practical experience and experiment go, there is nothing inconsistent with a belief that the tool attains a temperature of, say, 150 deg. Cent. or more at a cutting speed of 80ft. per minute, while the work does not reach 112 deg. Cent. until the cutting speed is about 110ft. per minute. It may perhaps be argued that if the first hump is an effect arising purely from the behaviour of the work-metal, then when the tool and not the work is changed, the hump ought to occur at the same cutting speed. It will be noticed that in such an experiment conducted by Messrs. Smith and Hey, the first humps on three of the curves are more or less in line, but that on the fourth curve the hump is considerably displaced to the left. Three of the second humps are also more or less in line, while the fourth is again displaced. Omitting the fourth curve, the evidence of the others inclines equally in favour of either series of humps being caused by

a change in the behaviour of the work-metal. The displacement of the fourth curve is curious and interesting. It seems to imply that the temperature reached by the work immediately under the cutting edge is considerably affected by the heat treatment to which the tool has previously been subjected. If such treatment or the absence of it is found to affect the thermal conductivity of the tool material, this supposition could be given a rational explanation.

It is to be very particularly noted that both Messrs. Smith and Hey's and Mr. Herbert's durability experiments were made with extremely fine feeds—feeds, in fact, of little more than one-thousandth of an inch per revolution of the work. It would appear to be established that as the rate of feeding is increased, the humps in the durability curve approach each other and move over towards the left; that is to say, the maximum durability occurs at a lower and lower speed. Ultimately, when the conditions of a roughing cut are reached, the humps appear to vanish altogether, and we get the familiar result that as the speed is increased—at all events, from 70ft. to 80ft. per minute upwards—the durability steadily falls off. Whether, as the speed is reduced below 70ft. or 80ft., the curve under roughing cut conditions trends continuously upwards, or whether it reaches a maximum and then falls towards zero smoothly or still showing relics of the humps, is not definitely established, for very little experimental work has been done on the earlier portion of the curve, except under light cut conditions. It is of relatively little practical moment what form the roughing cut durability curve assumes at low speeds, nor, it must be confessed, is there much practical application for the establishment of the fact that under very light cuts the durability curve is humped after the manner first established by Mr. Herbert. On the other hand, however, the scientific interest of the subject is very great, and might well lead to developments of considerable workshop importance. If they do nothing else, the Manchester experiments strongly suggest that a proper understanding of metal cutting action cannot be attained if we persist in neglecting the thermal aspect of the battle taking place between the tool and the work. Mr. Herbert's experiments on the change produced by temperature in the work-hardening tendency of metals have an interest of their own, quite outside their bearing on the durability of tools, and will no doubt be followed with very close attention by many concerned with the manipulation of metals otherwise than by cutting processes.

Railway Electrification.

Another paper on railway electrification was read and discussed last week at the Institution of Electrical Engineers. The "Future of Main-line Electrification on British Railways" was the title and Lieut.-Colonel H. E. O'Brien was the author. As railway electrification in this country is now almost at a standstill, electrical engineers seem to have come to the conclusion that the best thing to do is to read papers on the subject, but whether such papers have any influence on those who are in a position to set things moving is very doubtful. Since the railway grouping, important schemes have been abandoned. The York to Newcastle and the Brighton schemes are not to be undertaken, nor is there any intention at present of electrifying the suburban lines round Liverpool-street and to Tilbury, or the Caledonian Company's lines round Glasgow. The anxiety on the part of electrical engineers to stimulate interest in the matter is therefore not to be wondered at. Although it will probably be a long time before main line work in this country begins to make real headway, there is work that ought to be undertaken without delay, and if, as some contend, the railway grouping is responsible for stopping this work, the public should be made to understand the position. No one doubts that suburban electrification is beneficial, both to the public and to the railway companies themselves. Main-line electrification, however, is what Colonel O'Brien is concerned with, and he proves to his own satisfaction that the probable density of traffic in ton-miles on the main arteries is so great that the cost of energy, including all capital charges, would not be prohibitive, that the cost of the electric locomotive would not be a capital charge, and that when the reductions in the cost of locomotive operation and maintenance were taken into account, the total cost of locomotive operation would be substantially less for electricity than it is for steam. Of course, similar conclusions have been arrived at before by electrical engineers who have read papers. They do not, however, seem to have very much influence on the railway directors or traffic officers, who, according to Mr. Roger Smith, do not want to be bothered with electrification. The conclusions are, of course, based on general statistics, which railway people are better able to discuss than the average electrical engineer. Papers of this kind might prove more useful from a propaganda point of view if they were read before railway officials. Most electrical engineers, we presume, are convinced that the electric locomotive is an infinitely better machine than the steam locomotive. They claim, moreover, that, although its initial cost is high, it has a great earning capacity, a large overload capacity, and that it costs relatively little to maintain. They also realise that for the same weight the electric locomotive will develop more draw bar power than the steam locomotive. Many of these facts are also recognised by railway people. What they are probably in doubt about is whether, when capital charges and all things are taken into account, main-line electrification can be made to pay in this country. For that reason the paper should have been read before railway men, especially as very similar papers have previously been presented at the Institution of Electrical Engineers. Still, as Mr. F. Lydall said, the paper was of value to those who have to grapple with electrification problems, and we may assume, therefore, that the author has not wasted his time.

Naturally, the discussion was poor. We have never listened to a really good discussion on railway electrification at the Institution of Electrical Engineers, and we have given up all hopes of ever doing so. In this case, there were not many electrical points to discuss. The most interesting contribution came from Sir Philip Dawson, who was represented by Mr. A. E. Jackson. The speaker dealt mainly with Sir Philip's investigations in connection with the electrification of the Brighton Company's system in the suburban area, and the main line as far as Lewes, Brighton and Worthing. This investigation was subsequently checked and confirmed by the greatest continental authority. The investigation was carried out with the greatest care, and it involved the preparation of a complete scheme for electrification in all its details. The most interesting fact brought to light was that by far the most paying part of the whole proposition was the electrification of the main line to Brighton, An investigation such as this on a given length of line is to be regarded as of far greater importance than a paper that deals with the subject in a general way. In view of the thoroughness of the investigation and the conclusions arrived at, there is no technical reason, so far as we can see, why the work should not be proceeded with. It would provide employment for a number of skilled workers and reduce the large sum of money that is now being thrown away on doles, and incidentally it would prove a boon to the public. There is probably no stretch of main line in this country more suitable for electrification than the line to Brighton. To all intents and purposes, it may be regarded as a suburban line, and there is not much doubt that suburban electrification pays. The system used on it, moreover, is well suited for long-distance work. Indeed, the investigation to which we have alluded is said to have proved that it is better from every point of view than any other system. As regards other railways, however, the first thing to do is to select the lines on which electrification is likely to prove most profitable, for no one, except perhaps a few extremists, contemplates electrifying all the systems in this country at the present time. Having found the lines which appear to be most suitable for electrification, and assuming that the companies are prepared to consider the question of electrification, then the whole matter must be properly investigated as it has been investigated on the Brighton Railway, due consideration being given to the relative merits of the different systems. This brings us back to a branch of the subject which we have often discussed, and which has occasionally brought us into conflict with some of our readers. We are pleased to find that although Sir Philip Dawson is as anxious as anybody to see main lines in this country electrified, he still strongly supports the view that long-distance work demands high pressures. The hopeless confusion that exists concerning this question of economical pressure is shown by Mr. Williams's letter published in our last issue. No responsible engineer, it says, would ever dream of using 1500 volts for a 110-mile line, yet Colonel O'Brien is apparently advocating this pressure for the whole of the main lines in this country, and the same pressure has been adopted as standard in France. Railway electrification literature is full of conflicting statements, and we pity any poor railway officer who sits down and tries to learn anything from it. We find it stated in Colonel O'Brien's paper, for example, that transmission lines must not be installed on the railway on account of the undoubted interference troubles which would arise in connection with telegraph, telephone and signal circuits. At the meeting at which Monsieur Bachellery's paper was read, however, Colonel F. A. C. Leigh asked whether the 60,000-volt transmission lines, which are run on the same structures as the track overhead construction of the Midi Railway, had any effect on the communication circuits, and the answer given in the March issue of the *Journal* of the Institution of Electrical Engineers is that there is no interference, except in the case of a short circuit, when there is an inductive kick, which apparently does no harm.

Whilst there are many points to be cleared up in connection with main-line railway electrification, one thing, however, is certain. If the main lines of this country are to be electrified—and the wisdom of doing so is open to very serious question—we must have a simple and straightforward system. We do not want, and we must not on any account have, a system that involves the erection of innumerable sub-stations, containing converting machinery and attendants. As far as possible, the human element must be eliminated, for we know that it is this element that most frequently brings transport to a standstill. The automatic sub-station does not solve the problem, for it introduces very considerable complications and increases the capital outlay. Simplicity must be the keynote of main-line railway electrification. The place for all the machinery is in the power-house, and if electrical engineers cannot at present see their way clear to electrify main lines without putting down machinery on the railways as well, then our advice to the railway companies is to wait until they can. During the discussion on Colonel O'Brien's paper, Mr. F. Lydall referred to the very heavy trains that are hauled on American railways, and expressed the hope that eventually we should be able to talk about heavier loads in this country. That is a matter which should not be lost sight of. There is no telling what the railways may ultimately have to deal with, or what power it may be desirable to use for the propulsion of individual engines, and for that reason alone it is well to adopt a system that will enable the voltage to be raised without great expense and trouble, if at some time a higher pressure should be desirable. We do not for a moment suggest that it will ever be necessary to consider such powerful locomotives as those which are now being built for the Virginian Railway, but it is a matter of interest to note that the current which these engines will require could not possibly be collected from a 1500-volt overhead wire.

The Practical Man and Scientific Papers.

The recent meeting of the Institute of Metals once again raises a question by no means new in the history of our technical institutions. A considerable crop of papers was read and discussed, but most of them were of a distinctly scientific character, and the practical man asks of what use they were to him. There have, indeed, been some very definite echoes of a certain discontent among the members of this particular Institute on this very ground—some suggestion that its activities tend too much in the scientific direction and lack a sufficiently direct bearing upon the problems of the works and the factory. The criticism to a certain extent appears to be justified, since it is admitted that papers dealing directly with practical problems are few compared, for instance, with those dealing with fine points in relation to the complicated constitution of alloys. The Institute, not unlike its senior sisters, thus finds itself faced with the problem of finding "practical" papers. It is, however, obvious at first sight that such a problem offers exceptional difficulties, owing mainly to the inarticulateness of the practical man, when it comes to the reading or even the discussion of papers. It was noticed at the recent meetings, for instance, that the only papers which gave rise to any important discussion were those of the strongly scientific type, while those papers which dealt with practical questions were left undiscussed, except perhaps by a few of the so-called "scientific" members who, none the less, seemed quite able to enter into and discuss such practical matters.

If the practical man is unwilling or unable to produce or even to discuss papers on subjects that appeal directly to his colleagues, the Institute is

hardly to be blamed for the resulting preponderance of scientific papers; the remedy lies entirely with the practical man himself. If he takes a sufficiently active interest in the affairs of the Institute, and will take the trouble to secure the preparation and discussion of papers of the kind desired, the difficulty can be overcome, but that is the only possible remedy for the complaint in question. Meanwhile, however, we may well ask whether the complaint is, in itself, justified. It must be admitted, of course, that the practical man, immediately concerned with commercial production, is not in a position himself to understand, discuss and appreciate the more scientific metallurgical or technical papers. Such papers represent, if they are worth reading and publishing at all, the most advanced results of scientific research, and, consequently, are quite unavoidably of an advanced and often difficult nature. None the less, we suggest that by their publication and discussion our technical institutes are as truly serving their purpose and helping to advance the cause of the practical man himself, as if their papers were all of a practical nature. In them the results of research are given freely to all, the fullest and frankest discussion and criticism is invited, and, as a rule, if a practical man finds that he can make some use of a result, he is readily and freely afforded the best assistance that the research worker can give him. Is it, then, too much to expect the practical man to support, through his technical institutes, the work of the scientific research workers by affording them the opportunity for the publication and discussion of the best of their work? Our institutes, or some of them, do support research by carrying out or subsidising certain special researches, such as the Corrosion Research of the Institute of Metals or the Cutting Tools Research of the Institution of Mechanical Engineers. That is well, but their real opportunity for supporting and encouraging research in the fields of science connected with their own branch of technology lies in another direction, and that is in affording a good opportunity for the publication and discussion of scientific papers dealing with these subjects. For there are few opportunities for such publication and discussion. The purely scientific societies, such as the Royal Society, can find little or no room in their own limited publications for papers of this class. It must be borne in mind—and members of technical institutions scarcely realise this fact—that the very papers which they regard as too highly scientific would be, and actually are, rejected by the purely scientific societies as being of too technical a character to be suited for their publications! Metallurgy is in a particularly bad position in this respect, falling, as it were, between the two stools by being regarded as too scientific by the technical man and too practical by the man of pure science.

The Institute of Metals, by providing in its *Journal* and its meetings a ground for the discussion and publication of such work, has rendered a very real service, both to the scientific and the practical man. Since it was founded, there has been a very striking development of research activities on metallurgical subjects in this country, and this development has placed British scientific metallurgy admittedly well in the forefront of the world's progress in these matters. That is, to some extent, the direct result of the encouragement which the Institute has provided, and it is of the greatest importance from the view-point of the practical man himself. Industry, whether he likes it or not, is becoming increasingly scientific, and he is becoming increasingly dependent upon a supply of men able to work along the newer lines. It is the growth of schools of metallurgical research which provides him with such men, and it is largely to a continuance of such a supply that he must look for the future expansion and prosperity of his industry in a world where scientifically guided competition has to be met to an ever-growing extent. While, therefore, the practical man may well be asked to provide papers and discussions of direct interest to himself for the "Proceedings" of his institute, it is surely not too much to ask him, by his subscription and personal support, to aid the institute to carry on its vital work of encouraging research and the dissemination of the latest scientific knowledge, even if, for the time being, intricate diagrams and Greek letters make this appear indigestible to the man accustomed to deal with furnaces and workmen.

On his retirement from membership of the Indian Railway Board, Sir Danvers Waghorn has been succeeded by Mr. F. A. Hadow, the agent of the North-Western Railway of India.

Heat Engine and Boiler Trials.

On Tuesday next, April 8th, at 6 p.m., an important meeting will be held at the Institution of Civil Engineers to discuss "Standards of Comparison in Connection with the Thermal Efficiency of Internal-combustion Engines." The debate will be opened by Mr. G. James Wells, of whose address we give now a preliminary summary. The work of revision of Heat Engine and Boiler Trials is being carried out by a committee of the following bodies:—The Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, The Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association. A note on the work of the sub-committee on Steam Engine and Boiler Tests appeared in our issue of March 14th.

Summary of Mr. Wells' Address.

Engineering progress demands the revision of standards and ideals from time to time, and the committee which has recently been appointed to revise the report of a previous committee on the tabulation of the results of steam engine and boiler trials—revised 1913—will, by virtue of the extension of its terms of reference, require to consider certain questions dealt with by an earlier committee, which reported on the efficiency of internal-combustion engines (1905).

The 1905 committee reported in favour of the "air standard" as the then best ideal with which to compare the performance of internal-combustion engines, using air as the standard ideal working fluid, the specific heat of which was assumed to be constant. The committee stated definitely that these conclusions were only regarded as a temporary expedient, until such time as the requisite data were obtained, which would render possible a restatement of the ideals to be aimed at.

Sir Dugald Clerk, Professor Burstall, the late Professor B. Hopkinson, and others have done research work, which has widened our knowledge, and the critical and analytical work of others, all help materially towards more rational definitions of ideals and standards.

The ideal simple standard cycles applicable are the well-known "constant pressure" and "constant volume," together with the "Diesel" and "dual combustion," the last two being combinations of the two first mentioned. The thermal efficiencies of these cycles are stated usually in terms of temperature or of the compression ratio, but it is proposed to compute the efficiency in terms of the energy supplied and rejected in each cycle.

As regards the working fluid, it appears possible to replace the imaginary air with constant specific heat by means of a gas mixture whose properties approximate more closely to those possessed by the actual gas mixture found in internal-combustion engines. The work of Sir Dugald Clerk, the British Association Committee on Gaseous Explosions, and a formula proposed by Dr. Stodola, are examined and shown to be more closely in agreement than might be expected from the numerical values attached to the constants, and upon these a proposal is based that an imaginary fluid may be postulated with properties that give, on the whole, a fair approximation to the actual truth, certainly much closer than the air standard can possibly achieve.

The solution suggested is that, by means of a diagram—nomographic—and the data given by a mean indicator diagram, the temperatures, changes of total energy and internal energies may be found, in a manner somewhat similar to that employed in conjunction with a Mollier chart in connection with turbine problems. A sample table is added giving the internal and total energies reckoned from absolute zero of temperature, a sort of table of properties of gases for the use of internal-combustion engineers. An entropy chart is also combined with the nomogram, which enables the actual engine heat cycle to be readily compared with the suitable ideal cycle, thus giving directly a visual impression of the engine's departure from the ideal, and a quantitative measure of the relative efficiency.

The chart thus built up is then tested by means of published tests, of a gas engine and two Diesel engines. In the case of the gas engine, three tests were published, and efficiency figures found by means of the diagram were 0.360, 0.359, and 0.357, as compared with the figure 0.3535 computed and published at the date of the tests. The diagram gave a mean pressure of 89 lb. per square inch, which agrees exactly with that obtained from the cards. Similar results are obtained in the latter case.

Finally, it is claimed that the time has arrived when engineers should take the fullest advantage possible of the advances made in the knowledge of the behaviour of the gases in internal-combustion engines, to revise their standards and ideals, for use in internal-combustion engine problems.

Literature.

SHORT NOTICES.

Industrial Furnaces. Vol. I. By W. Trinks. London, Chapman and Hall. Price 22s. 6d. net.—Mr. W. Trinks is Professor of Mechanical Engineering in the Carnegie Institute of Technology in New York; and this volume is a reprint of portions of a series of articles on heating and annealing furnaces which he contributed to two American journals. The subject is, he considers, too large for one volume, and it has been divided so that the volume under review is confined to a presentation of the fundamental principles and facts which underlie all industrial heating operations and furnace design, and with those applications which are independent of the nature of the fuel or energy supply. The second volume—to be published in the near future—will contain, we are told, a thorough discussion of the practical side of, and apparatus for, the generation of heat by combustion of fuel or by electrical methods. In the present volume we find six chapters dealing with Heat Capacity; Fuel Economy; Heat-saving Appliances; Strength and Durability and Movement of Gases in Furnaces. Many graphs showing at a glance the relations between the large number of variables, and designed to simplify furnace efficiency calculation are included. The axiom that brain work once done should not be done over again except for educational purposes is emphasised by the author, and all the theories advanced have been tested and proved in actual furnace practice. This is a useful book upon a subject the technical literature of which is scanty. The author in his Preface states that most of his material had to be collected from scattered publications or from private communications.

The Control of the Speed and Power Factor of Induction Motors. By Professor Miles Walker. London: Ernest Benn, Limited. Price 18s. 6d. net.—In view of the increasing use of alternating current for power purposes this book should meet with appreciation. With modern motors, such as those with which the author deals, power-factor troubles can be overcome and economical speed variation can be secured. As the author says, there is no reason now why a large induction motor should not run at unity power factor or even with a leading power factor. Moreover, induction motors having eighteen economical speeds between 1000 and 3500 revolutions per minute are now supplied for driving air compressors, and the power user will, therefore, find that these machines are much more suitable for many industrial purposes than they were in the past. Although the book contains a considerable amount of theoretical information which is of more value to students and designers than it is to those who employ electricity for driving factories, &c., it also contains practical information which will appeal to those who are associated with the installation and operation of electric motors. The principles and possibilities of modern induction motors are perhaps none too well understood, and Professor Miles Walker's book appears to fill a distinct gap in electrical literature.

Oil-burning Installations. By C. C. Pounder. Manchester: Emmott and Co. 1924. 12s. 6d. net.—At the present time, when so many sea-going vessels are being altered so that they may use oil fuel instead of coal, this volume is specially welcome, although it is not entirely confined to marine practice. The author does not occupy a large amount of space by cataloguing the great variety of pumps, burners, &c., on the market, and contents himself rather with descriptions of a few typical examples. On the other hand, however, he deals exhaustively with the general lay-out of oil-burning installations, and gives the reasons for the adoption of the arrangements described. The illustrations in the book are profuse and explicit, and it is evident that the author is well acquainted with his subject.

Colliery Electrical Engineering. By C. M. Harvey. London: Sir Isaac Pitman and Sons, Limited. Price 15s.—As a text book covering the application of electrical power to mining, this volume complies fairly well with the average student's or engineer's requirements. The author has acted wisely in omitting to deal with fundamental principles, and in confining himself to practical mining work. The subject which the book covers is now a very wide one, but the author seems to have touched upon most of the important branches, and the volume should, we think, prove decidedly useful to engineers connected with mines and others who desire to acquire general knowledge on the use of electricity in mines.

BOOKS RECEIVED.

Sugar Machinery. By A. J. Wallis-Tayler. London: William Rider and Son, Limited, 8, Paternoster-row, E.C. 4. Price 12s. 6d. net.

Modern English Architecture. By Charles Marriott. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 21s. net.

Physics and Chemistry of Mining. By T. H. Byrom. London: Crosby, Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 6s. net.

Théorie Générale sur les Courants Alternatifs. By M. E. Piernet. Paris: Gauthier-Villars and Cie., 55, Quai des Grands-Augustins. Price 12 f.

Low Temperature Carbonisation. By S. N. Wellington and W. R. Cooper. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. 2. Price 25s. net.

The Journal of the Iron and Steel Institute. Volume CVIII. Edited by G. C. Lloyd. London: Published at the offices of the Institute, 28, Victoria-street, S.W. 1.

Converting a Business into a Private Company. Fourth Edition. By Herbert W. Jordan. London: Jordan and Sons, Limited, Chancery-lane, W.C. 2. Price 1s. net.

Text-book of Industrial Cost Accounting. By P. M. Atkins. London: The McGraw Hill Publishing Company, Limited, 6-8, Bouverie-street, E.C. 4. Price 17s. 6d. net.

Hardness and Cutting Trials of a Tool Steel.*

By DEMPSTER SMITH and ISRAEL HEY.

THE discussion on the recently published report of the Lathe Tool Research Committee† revealed a desire for further information on the behaviour of tools when taking extremely fine cuts over a wide range of speeds and the quality and treatment of the tool steel most suitable for use under such conditions.

Although the behaviour of a tool is more easily studied when taking very fine than when taking coarse cuts, it cannot be assumed that the cutting phenomena under both conditions are the same. The breakdown point of a roughing tool, however, is easily observed, but that of a tool taking a fine cut is obscure, and for an accurate measure of the durability of the latter a different standard is necessary.

HEAT TREATMENT OF THE TOOLS.

The procedure followed in the treatment of the tools was that adopted by the Manchester Committee.

Hardening.—The tools used were of A.W. high-speed steel. These were slowly heated in the smith's hearth to a temperature of about 800 deg. Cent., transferred to a hotter part of the fire and rapidly but uniformly heated to about 1100 deg. Cent. and forged to shape. No heavy work on the tool was attempted after the temperature had fallen to about 900 deg. Cent. After forging, the tools were ground (dry) to shape in a tool grinding machine. They were then pre-heated in a muffle furnace to a temperature of about 800 deg. Cent. and transferred to a high-temperature furnace at 1350 deg. Cent., where they remained until the entire surface at the nose was in a state of mild ebullition (sweating stage) and the temperature had reached about 1300 deg. to 1320 deg. Cent. The tools were then withdrawn and cooled in an air blast of ample volume and at a pressure of about ¼ lb. per square inch.

Tempering.—The method followed was to cool the tools entirely in the air blast and to reheat them in a muffle furnace at a temperature of 580 deg. Cent., or whatever temperature was decided upon, and to hold the tools at such temperature for an hour. This method requires too much care to be recommended for ordinary workshop conditions.

SOME HARDNESS OBSERVATIONS ON A TOOL STEEL.

While the Manchester Committee did not succeed in establishing a close relation between the resistance of cold high-speed steel to indentation or flow and its cutting capabilities, yet the hardness figures obtained gave an indication of the most desirable treatment for this grade of steel. The late F. W. Taylor maintained that there was no connection between the hardness of a tool as ordinarily understood and "red hardness," and apparently the only way he had of determining the degree of "red hardness" was to put the tool to an actual cutting test and observe its durability. It must be admitted that if "red hardness" is understood to be that property which enables a tool to retain its cutting edge even when heated to a fairly high temperature, then a measure of that property is most likely to be obtained when the steel is in a heated condition. Yet there is always the temptation when a new method of measuring hardness appears to try that method on the steel when cold in the hope that the latter may be made to divulge its secret. When the Herbert Pendulum hardness tester was placed on the market the authors decided to carry out a series of trials with it, on tool steels which had received various heat treatments.

The hardness numbers obtained by the Brinell machine and the Pendulum hardness tester for A.W. high-speed steel specimens are plotted in Fig. 1. The hardness numbers are plotted as ordinates on an abscissa of secondary heat treatment temperature to which the specimens were subjected after hardening. These observations are joined by full lines, and were taken in the ascending order of temperature.

The graph of the Brinell values shows a hardness of 664 for a secondary heat temperature of 575 deg. Cent., which is slightly higher than that for the steel when quenched out. The hardness decreases slightly as the temperature increases up to about 450 deg. Cent. and then rapidly increases up to a temperature of 575 deg. Cent. Treatment at higher temperatures results in a rapid decrease of hardness up to 800 deg. Cent., although there is a slight check in the rate of softening about 600 deg. Cent.

The "Time" hardness graph agrees with the Brinell results in a most remarkable manner. These, together with the "Scale" tests, confirm one another and show that a secondary treatment at a temperature of 575 deg. Cent. gives a maximum secondary hardness and that this maximum is reached by first passing through a minimum point at a temperature of about 450 deg. Cent.

So far the agreement in the character of the Brinell and the Pendulum tests suggests that for a particular grade of steel hardened and secondarily heat treated at different temperatures, the same physical property which may be termed "hardness" is indicated.

In Fig. 1 the dotted lines indicate the Brinell and Pendulum observations for hardened specimens of A.W. high-speed steel, subjected to further heat treatments in descending order below 575 deg. Cent. after being secondarily heat treated at 575 deg. Cent.

Each of the dotted lines show that any number of subsequent heatings at temperatures below 575 deg. Cent. do not appreciably affect the hardness of the steel, i.e., a secondary heating at 575 deg. Cent. establishes a stable condition of hardness up to that temperature for this grade of steel.

Time Hardness Tests on Heated Specimens.—Time hardness tests were made on heated specimens of the material operated upon in the cutting trials. The results are shown in Fig. 3. The graph shows a diminution in hardness with increase in temperature up to about 115 deg. Cent., and an increase beyond that temperature, but the rate of increase appears to diminish as the temperature rises. The scope of the experiments requires to be extended before an opinion can be expressed as to the hardness at the higher temperatures.

A similar series of tests has been planned for specimens of the tool steel, but is not sufficiently advanced to be put forward.

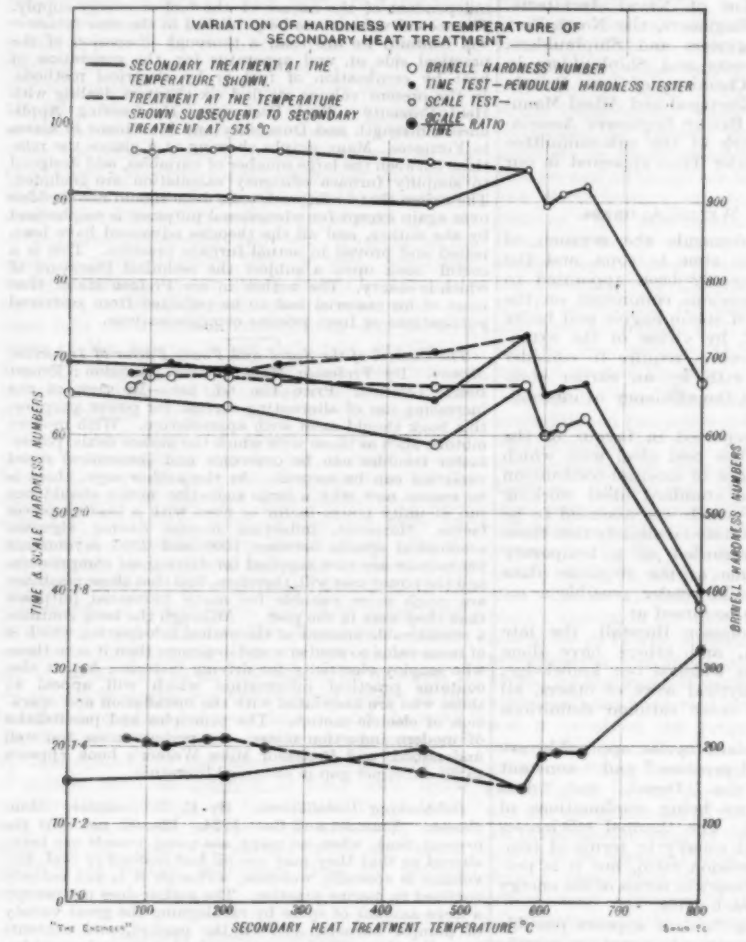

VARIATION OF HARDNESS WITH TEMPERATURE OF SECONDARY HEAT TREATMENT
SECONDARY TREATMENT AT THE TEMPERATURE SHOWN.
TREATMENT AT THE TEMPERATURE SHOWN SUBSEQUENT TO SECONDARY TREATMENT AT 575 °C
BRINELL HARDNESS NUMBER
TIME TEST—PENDULUM HARDNESS TESTER
SCALE TEST—
SCALE / TIME RATIO
TIME & SCALE HARDNESS NUMBERS
BRINELL HARDNESS NUMBERS
SECONDARY HEAT TREATMENT TEMPERATURE °C
"THE ENGINEER"

FIG. 1

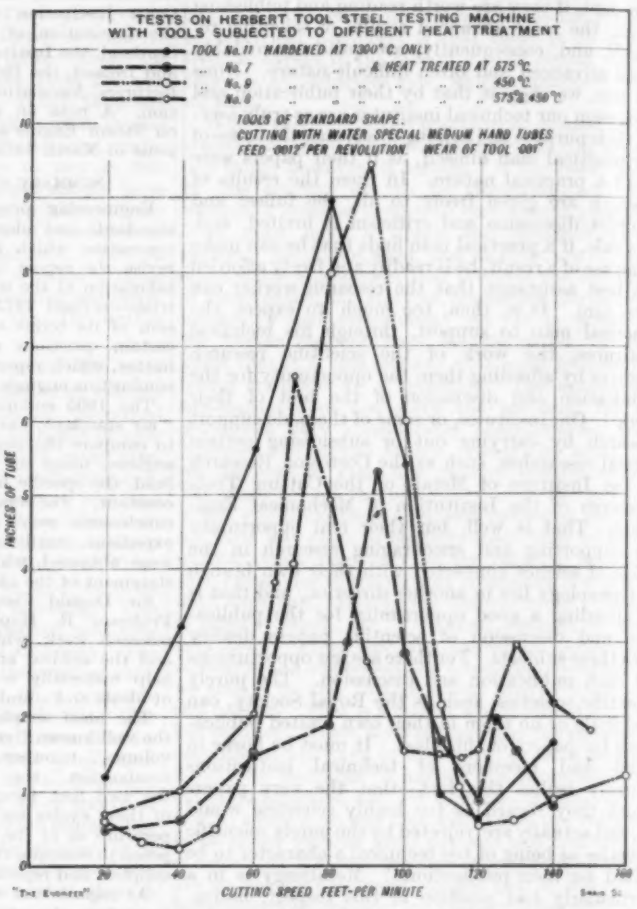

TESTS ON HERBERT TOOL STEEL TESTING MACHINE WITH TOOLS SUBJECTED TO DIFFERENT HEAT TREATMENT
TOOL No. 11 HARDENED AT 1300° C. ONLY
No. 7 & HEAT TREATED AT 575 °C.
No. 9 450 °C.
No. 8 575° & 450 °C.
TOOLS OF STANDARD SHAPE.
CUTTING WITH WATER SPECIAL MEDIUM HARD TUBES
FEED .0012" PER REVOLUTION. WEAR OF TOOL .001"
INCHES OF TUBE
CUTTING SPEED FEET-PER MINUTE
"THE ENGINEER"

FIG. 2

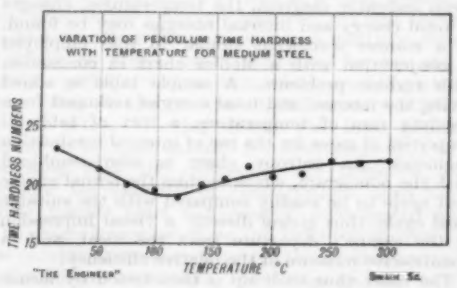

VARIATION OF PENDULUM TIME HARDNESS WITH TEMPERATURE FOR MEDIUM STEEL
TIME HARDNESS NUMBERS
TEMPERATURE °C
"THE ENGINEER"

FIG. 3

CUTTING TESTS IN THE HERBERT TOOL STEEL TESTING MACHINE.

Experiments such as those carried out by the Manchester Committee on fairly heavy cuts and at high speeds would have the effect of raising the temperature of the tool to such a degree as would call for the red hardness property of the steel.

With the object of determining the variation in durability with cutting speed when taking fine cuts where the tool is probably not raised to such a high temperature, a series of tests was carried out on the Herbert tool steel testing machine, where an extremely fine cut could be obtained over a fairly large range of speeds.

This machine resembles a drilling machine in form. The spindle carries the work to be operated upon, which takes the form of a steel tube 18in. long, ¾in. external diameter, $^1/_{16}$in. thick. The tool is held in a vice situated below the tube and the end of the latter is kept in contact with the cutting edge of the tool by means of weights placed on the spindle sleeve, but the feed is prevented from exceeding 0.0012in. per revolution. Speeds up to 180ft. per minute are obtained by a small electric motor operating through a four-speed gear-box and a variable-speed friction drive. An autographic record of the amount of tube cut away for a predetermined amount of wear of the cutting edge of the tool is given on a drum which rotates at a rate proportional to the speed of the spindle. The test proceeds until wear of the cutting edge allows the tube to touch a ball situated $^1/_{1000}$in. below the original level of the cutting edge.

A series of trials was made on medium hard steel tubes with four tools of A.W. high-speed steel, heat treated as follows:—

No. 11 hardened at 1300 deg. Cent. only.

No. 7 hardened at 1300 deg. Cent. and heat treated at 575 deg. Cent.

No. 9 hardened at 1300 deg. Cent. and heat treated at 450 deg. Cent.

No. 8 hardened at 1300 deg. Cent. and heat treated at 575 deg. and 450 deg. Cent.

The "inches of tube" cut away during the tests are plotted against the corresponding speeds in Fig. 2.

A peculiar feature of these trials is that the amount of tube cut away increases with an increase in speed up to a certain value and then decreases rapidly, but again increases slightly at speeds between 120ft. and 140ft. per minute. This phenomenon is totally different to the

* Paper read before the Manchester Association of Engineers, March 28th.—Abstract.

† Report of the Lathe Tool Research Committee published by His Majesty's Stationery Office, 1922. Price 5/- net.

results obtained when taking heavy cuts on steel where the life of the tool invariably increased as the speed decreased. The results are generally in accordance with those previously obtained by Mr. E. G. Herbert. Because of the peculiar character of the graphs, arrangements were made to carry out a series of tests on fine cuts in a lathe, over a greater range of speeds and where the conditions are more rigid and in line with workshop practice.

Cutting Trials with Tools Held in the Turret of an Ordinary Lathe.

Measure of Durability or Life of Tool.—The difficulty which immediately presented itself was the fixing of the standard of wear or measure of durability or performance. Mr. E. G. Herbert adopted $^1/_{1000}$in. wear of the cutting edge, but all devices evolved to do this in the lathe tended to sacrifice the rigidity sought.

Results have been advanced on different occasions to show that the vertical force on the tool for a compact shaving remains practically constant at all speeds. Having this in mind, it was thought that by providing a sensitive arrangement for measuring this force, the work done for a certain percentage increase of the initial force would afford a suitable standard.

When a certain percentage increase of the initial force is taken as a measure of performance, the curves shown in Fig. 4 are obtained. The percentages shown are 5, 10, and 15. The character of the three curves is alike, and it was decided to take a value of 10 per cent. increase on the initial force as the measure of performance for subsequent durability trials. With a 10 per cent. increase in the initial force the point of the tool is worn away to about $^{15}/_{1000}$in.

The Cutting Force Dynamometer.—For the purpose of measuring the vertical force during the cutting process with a tool taking fine cuts, a force dynamometer was designed to fit the turret of a No. 4 Herbert combination lathe. The force on the tool is balanced by a weight on a steelyard with a graduated scale. The steel-yard is free to float between stops carried on a bracket from the turret. The turning effort due to the tool and holder is balanced by a separate adjustable weight on an arm beneath the steel-yard.

When in use the dynamometer is very sensitive, a movement either way of $^1/_{16}$in. of the weight along the scale being sufficient to bring the lever against the stop.‡

The Lathe.—The machine was of the standard type with an all-gear headstock and single pulley drive. An additional set of wheels was inserted in the feed train in order to give a traverse of 0.0013in. per revolution of the work and thereby approximate the traverse of the Herbert tool steel testing machine.

Shape of Tools.—All tools used in this series of trials were ground to a side cutting angle of 60 deg. (no front top rake) with front and side clearance of 1½ deg., and a front top clearance of 3 deg. The corners of the tools which engaged with the bar were always kept square, i.e., no nose radius. The tools were set up with the cutting edge in a horizontal plane, and in line with and at right angles to the axis of the test bar.

‡ A drawing and further details of the dynamometer will be found in the original paper.—ED. THE E.

Variation in the Vertical Force with Speed of Cutting.

Although various experimenters have put forward results showing that the vertical force on moderately heavy cuts remains constant at all cutting speeds, it was deemed advisable to put this to test before proceeding with the durability or performance trials.

A series of preliminary trials on medium steel when cutting without a cooling medium was therefore undertaken at various speeds in which the force exerted on the tool was observed as the cutting progressed. The results of these trials are shown in Fig. 5, where the cutting force is plotted as ordinate on an abscissa of time, and different shapes of spots are used to indicate the tests made at different speeds. These tests were made with a tool of inferior steel to that used in the later durability trials, but repeated experiments with standard A.W. tools revealed the same characteristics. The value of the initial force is seen to vary as also the rate of increase of the vertical force with speed of cutting.

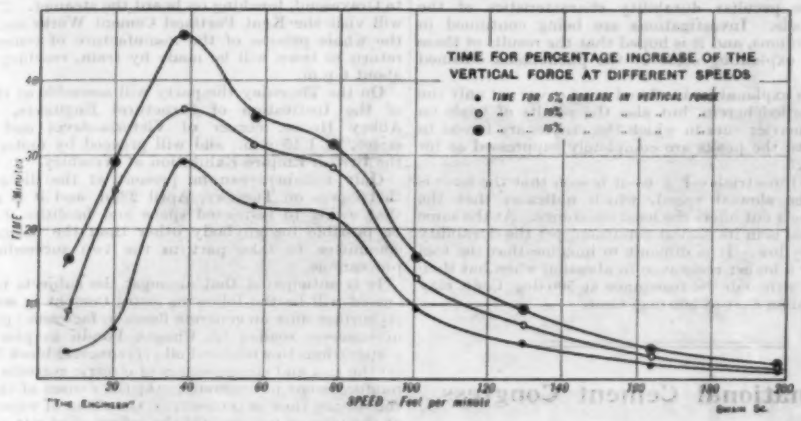

TIME FOR PERCENTAGE INCREASE OF THE VERTICAL FORCE AT DIFFERENT SPEEDS
TIME – Minutes
SPEED – Feet per minute
"The Engineer"

FIG. 4

With regard to the latter it is shown that for speeds of 8ft. and 20ft. per minute the force gradually increases with the time of cutting, and after thirty minutes the rate of wear at 20ft. per minute considerably increases, but at the speed of 8ft. per minute the accelerated rate of wear is delayed. A peculiar feature of these trials is that between speeds of 40ft. and 100ft. per minute the force gradually diminishes at the commencement of the trial and afterwards increases. The diminution of the force in the early stages is due to a grooving of the upper face of the tool. At speeds above 100ft. per minute the diminution of force is not apparent, but the force increases rapidly from the commencement of the trial.

The value of the *initial* force at different speeds shown in Fig. 5 has been reproduced in the uppermost curve of Fig. 6, in order to show how this force varies with the speed of cutting. This change in the force with speed is not due to any change in the initial sharpness of the tools, variation in depth of cut, or other controllable conditions in the trials. The further trials with tools Nos. 2 and 4, having a 60 deg. cutting angle shown in the lower curves of Fig. 6, support these observations. These were obtained by taking a fresh tool and observing the force at the lowest speed, and each successive increase of speed up to 160ft. per minute without withdrawing the tool. On reaching the latter stage the tool was re-ground and the test repeated in the reverse order of speed. Completing the series without withdrawing the tool ensured a uniform depth of cut throughout. The cutting time taken for a complete set of observations was about five minutes, so that the blunting effect would be small.

The frictional resistance of dry metal surfaces in contact diminishes as the speed of rubbing increases, although not in direct proportion, and this would result in a diminution of the vertical component of the frictional force acting upon the top face of the tool with a corresponding diminution in the vertical force. Experiments with a 90 deg. cutting angle tool, however, showed that the effect due to shaving friction was small, and consequently the shape of the curve is not altogether due to friction.

An examination of the shaving shows that at a speed of 8ft. per minute the shaving spreads broadwise and is uniform in thickness. With increase in speed up to about 100ft. per minute the shaving spreads at the outer edge and is tapered in section, but as the speed is further increased to 200ft. per minute the shaving again spreads to the width attained at the low speed.

An examination of the tools shows that at slow speeds there is considerable rubbing at the corner and front face, but this diminishes as the speed increases, and at the high speeds the pressure of the cut causes the metal of the tool to flow and accentuate the groove in the upper surface.

The above effects do not satisfactorily explain away the peculiarity of the graphs, and the reason for such must be sought for elsewhere. It is clear that the conditions or quality of the tool steel cannot enter into the results of the initial force, and the only other thing involved is the bar itself. In removing a shaving the metal is crushed and torn from the stock, and in the process the temperature of the metal is raised, particularly at that part where crippling occurs. It is this change in the condition of the steel being cut that is largely responsible for the character of the initial force curve.

In a series of experiments made by Professor Martens on heated mild steel specimens in tension, the elastic, yield and maximum stress varied with the temperature as shown in the upper portion of Fig. 7. It is reasonable to assume that the behaviour of specimens in compression up to the elastic limit would be similar to these. A further series of experiments was recently made by Mr. H. Carrington, M.Sc. Tech., on heated specimens subjected to bending, and the results of these are shown in the lower part of Fig. 7.

Both sets of experiments show a decided fall in the stress from the normal temperature to about 100 deg. Cent., and a gradual increase from that temperature to about 250 deg. Cent. when the stress again diminishes with increase in temperature. The relatively small force on the tool at the lowest speed is due to a rise in temperature of the shaving where crippling occurs to something in the neighbourhood of 100 deg. Cent. The force on the tool at the lowest speed corresponds to the elastic stress at 100 deg. Cent. With a stream of water playing on the shaving this temperature is reduced and the force on the tool is increased, and under such conditions the minimum force on the tool is not reached until a speed of about 30ft. per minute is attained.

Similar evidence of the change in the condition of the steel due to change in temperature is shown in Fig. 3, which gives the time hardness at various temperatures for the steel used in these trials.

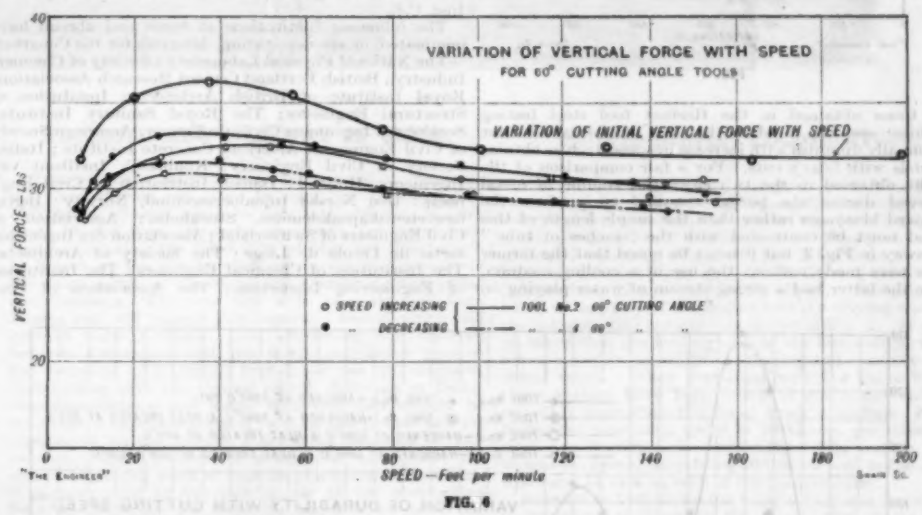

VARIATION OF VERTICAL FORCE WITH SPEED
FOR 60° CUTTING ANGLE TOOLS
VARIATION OF INITIAL VERTICAL FORCE WITH SPEED
VERTICAL FORCE – LBS.
SPEED INCREASING
DECREASING
TOOL No.2 60° CUTTING ANGLE
" " 4 60° " "
SPEED – Feet per minute
"The Engineer"

FIG. 6

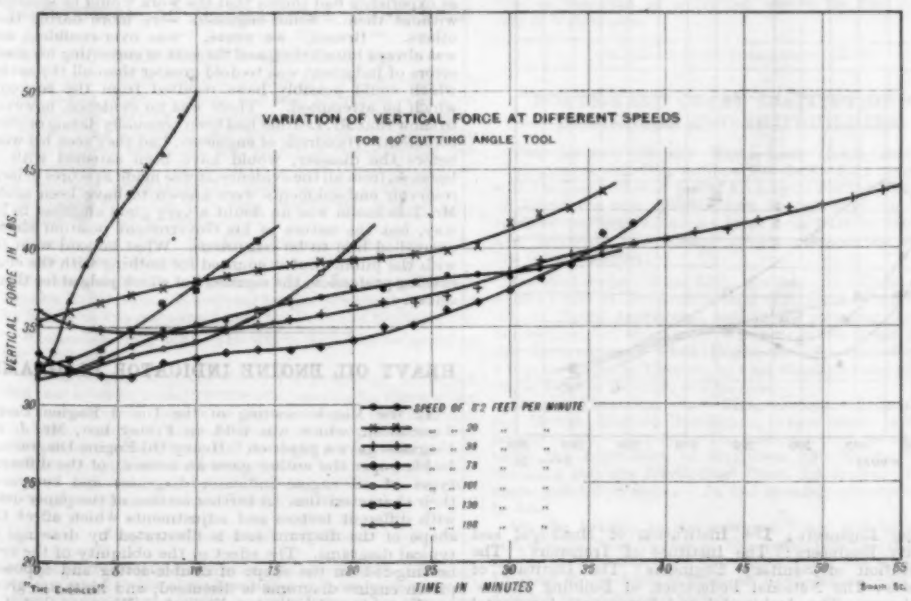

VARIATION OF VERTICAL FORCE AT DIFFERENT SPEEDS
FOR 60° CUTTING ANGLE TOOL
VERTICAL FORCE IN LBS.
SPEED OF 8·2 FEET PER MINUTE
" " 20 " "
" " 38 " "
" " 73 " "
" " 101 " "
" " 139 " "
" " 198 " "
TIME IN MINUTES
"The Engineer"

FIG. 5

Durability Trials with Hardened Tools Subjected to Different Subsequent Heat Treatments.

The results obtained in these experiments are shown in Fig. 8, where the time for the tool to attain a 10 per cent. bluntness is plotted as ordinate on a base of speed.

The cut taken in all cases was 0.0625in. deep by .0013in. traverse and no cooling medium was used.

The medium steel operated upon was of the following composition:—Carbon, 0.35; silicon, 0.15; manganese, 1.03; sulphur, 0.06; phosphorus, 0.04. The results,

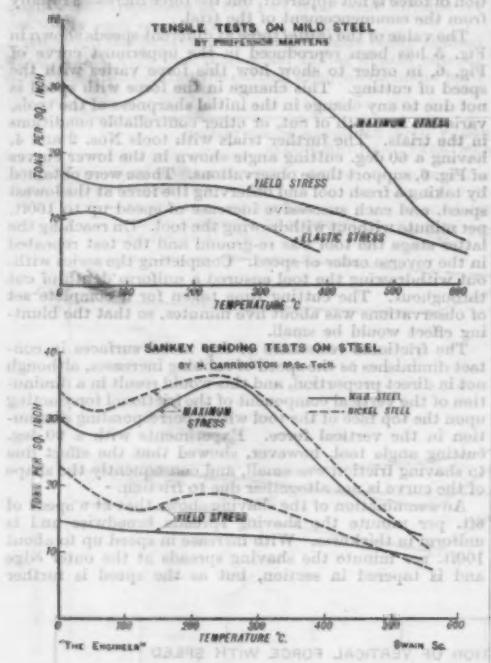


FIG. 7

like those obtained in the Herbert tool steel testing machine—see Fig. 2—show that the durability does not continually diminish with increase in speed such as obtains in trials with heavy cuts. For a fair comparison of the results obtained in the two cases the volume of metal removed during the period required to produce the standard bluntness rather than the simple length of this period must be contrasted with the "inches of tube" cut away in Fig. 2, but it must be noted that the former trials were made without the use of a cooling medium, while the latter had a strong stream of water playing on the tool face. Again, the material in the latter trials was considerably harder.§

A detailed examination of the results shows that for the lower speeds the hardened only tool gives the best results, but the relative performances of the tools do not correspond. Lest any mistakes had been made in the heat treating of the tools or accident had occurred during the tests, trials were made with fresh tools to check the results obtained at critical points. These are shown by the square spots in Fig. 8, and confirm the previously obtained data in a most remarkable way. It is apparent that for such light cuts there is little to be gained by giving the tools a secondary treatment, as the temperature to which the tools are raised does not bring into play the "red hardness" quality of the steel except possibly at the higher speeds.

It is equally clear from the position of the peaks or change in the direction of the curves that there is a change in the condition of the steel being cut as well as in the tool steel, and that the change in the latter is affected by the previous heat treatment. The data at hand is insufficient to enable one to co-relate the various factors in order to explain the peculiar durability characteristics of the different tools. Investigations are being continued in several directions, and it is hoped that the results of these will aid in explaining some of the phenomena outlined above.

Whatever explanation is offered must cover not only the results recorded herein, but also the results of trials on gradually heavier cuts in which the graphs are forced to the left until the peaks are completely suppressed as for heavy cuts.

From the force trials—Fig. 6—it is seen that the force is least at the slowest speed, which indicates that the material being cut offers the least resistance. At the same time the tool is in its coolest condition, yet the durability is extremely low. It is difficult to imagine that the tool would offer a higher resistance to abrasion when hot than when cold, although the resistance at 500 deg. Cent. may be greater than that at 300 deg. Cent.

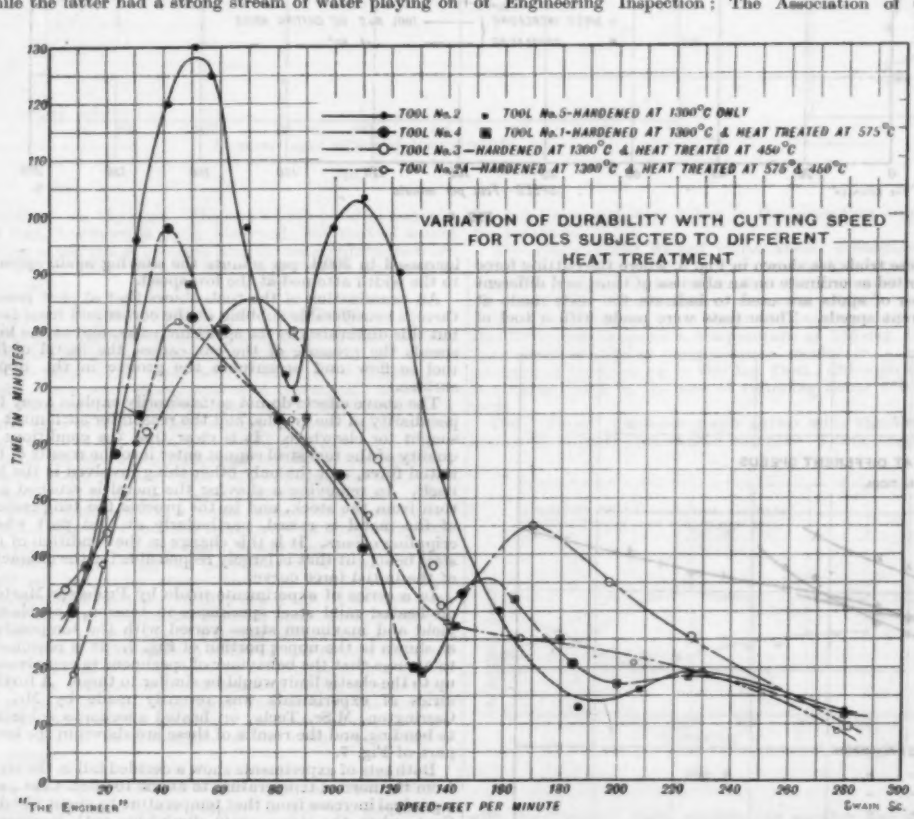

TOOL No. 2
TOOL No. 4
TOOL No. 3—HARDENED AT 1300°C & HEAT TREATED AT 450°C
TOOL No. 2A—HARDENED AT 1300°C & HEAT TREATED AT 575°& 450°C
TOOL No. 5—HARDENED AT 1300°C ONLY
TOOL No. 1—HARDENED AT 1300°C & HEAT TREATED AT 575°C
VARIATION OF DURABILITY WITH CUTTING SPEED FOR TOOLS SUBJECTED TO DIFFERENT HEAT TREATMENT
TIME IN MINUTES
SPEED-FEET PER MINUTE
"THE ENGINEER"
SWAIN Sc.

FIG 8

§ Fig. 8 re-plotted on the basis of amount of metal removed will be found in the article by Mr. E. G. Herbert elsewhere in this issue.—Ed. The E.

International Cement Congress.

An International Cement Congress will be held at Olympia during the course of the Building Exhibition under the ægis of the Institution of Structural Engineers. The committee dealing with the Congress is as follows:—Mr. H. K. G. Bamber, Professor Henry Adams, M. Inst. C.E., Mr. D. B. Butler, A.M. Inst. C.E., Mr. W. J. H. Loverton, Major James Petrie, President of the Institution of Structural Engineers, and Mr. R. W. Vawdrey, A.M. Inst. C.E.

The following Institutions at home and abroad have nominated, or are nominating, delegates for the Congress:—The National Physical Laboratory; Society of Chemical Industry; British Portland Cement Research Association; Royal Institute of British Architects; Institution of Structural Engineers; The Royal Sanitary Institute; Société des Ingénieurs Civils de France; American Society of Civil Engineers; American Concrete Institute; Italian Society of Civil Engineers; Koninklijk Instituut van Ingenieurs, Holland; Danish Institution of Civil Engineers; Den Norske Injenioersorenind, Norway; Ingeniorsvetemskapsakdemion, Stockholm; Association of Civil Engineers of Switzerland; Association des Ingénieurs sortis de l'école de Liége; The Society of Architects; The Institution of Chemical Engineers; The Institution of Engineering Inspection; The Association of Consulting Engineers; The Institution of Municipal and County Engineers; The Institute of Transport; The Institution of Sanitary Engineers; The Institute of Physics; The National Federation of Building Trades' Employers; The Architects' and Surveyors' Assistants' Professional Union; The Chemical Society; The British Engineering Standards Association; The Institution of Royal Engineers; The Society of Engineers; The Faraday Society; and The Royal Microscopical Society.

The following programme has been arranged:—Tuesday, April 22nd, 11 a.m., delegates and others will assemble in the Small Conference Hall at the Building Exhibition, Olympia, London, S.W. 1, where they will be received by Major James Petrie, President of the Institution of Structural Engineers. The party will be conducted round the Exhibition by the director, Mr. H. Greville Montgomery, and will then be entertained at a luncheon by invitation of the Council of the Institution of Structural Engineers and the Directors of the Building Exhibition. In the afternoon from 3 p.m. to 6.30 p.m. there will be discussion of papers.

On the Wednesday the party assemble at 9.30 a.m. at the Old Swan Pier Landing Stage at London Bridge, and will be taken, by invitation of the Directors of the Associated Portland Cement Manufacturers, by river to Gravesend, lunching on board the steamer. The party will visit the Kent Portland Cement Works and inspect the whole process of the manufacture of cement. The return to town will be made by train, reaching London about 6 p.m.

On the Thursday the party will assemble at the offices of the Institution of Structural Engineers, 231-235, Abbey House, corner of Victoria-street and Tothill-street, at 1.45 p.m., and will proceed by motor to visit the British Empire Exhibition at Wembley.

Only members can be present at the discussion on the papers on Tuesday, April 22nd, and it is regretted that owing to restricted space and facilities it will not be possible for anybody other than the delegates and committee to take part in the two succeeding days' programme.

It is anticipated that amongst the subjects to be discussed will be the following:—(*a*) Cement in sea water; (*b*) surface dust on concrete floors in factories; (*c*) cement in concrete roads; (*d*) Ciment Fondu in practice; (*e*) preparations to withstand oil; (*f*) concrete block building; (*g*) the risk and consequences of electric currents reaching reinforcement in concrete; (*h*) the causes of changes in the setting time of cement; (*j*) the effect of water content at the time of testing; (*k*) the influence of size and shape in compression test blocks; (*l*) microscopy of cement; (*m*) porosity of concrete blocks; (*n*) the use of sea water in mixing.

SIXTY YEARS AGO.

In our issue of April 1st, 1864, we reported the conclusion of the inquest on the victims of the Bradfield reservoir disaster. By the sudden bursting of the dam on March 12th, when it was almost completed, between 250 and 300 inhabitants of Sheffield lost their lives and great damage was done to house property and factories. The jury, after a protracted inquiry, to which many experts contributed their views, expressed the opinion that there had not been "that engineering skill and that attention to the construction of the works which their magnitude and importance demanded." Some of the witnesses and experts, notably Mr. R. Rawlinson, a Government engineer, severely criticised the plan adopted by the designer, Mr. Leather, of carrying the outlet pipes from the reservoir through the earthwork embankment, the objection being that should a pipe fail or leak the trouble would pass undetected until the creeping water destroyed the tightness of the puddle trench or wall and possibly brought the dam down. Mr. Leather, while paying attention to this view, was of the opinion that the most likely cause of the disaster was a slip of the land outside the area covered by the works. It would appear that signs of settlement had been detected in a house in the valley and that the original site for the dam had been abandoned in favour of one higher up because the strata had been discovered to be in a disturbed condition. In the course of a leading article on the disaster and the inquiry into it, we defended Mr. Leather. The public, we remarked, was too ready to say that an engineer in the execution of his works should exercise the utmost possible care. Even supposing that "the utmost possible care" could be defined or estimated, we argued that he should do nothing of the sort. There was, we said, no limit to the costly precautions which an engineer might take in carrying out a work, but there was a limit beyond which such precautions became unnecessary, as experience had shown that the work would be sufficient without them. Some engineers were more daring than others. "Brunel," we wrote, "was over-confident and was always blundering, and the cost of correcting his many errors of judgment was tenfold greater than all the saving which could possibly have resulted from the economy which he attempted." There was no evidence, however, to show that Mr. Leather had been unusually daring or over-confident. Hundreds of engineers, had they seen his work before the disaster, would have been satisfied with it, because, from all the evidence, it was made as scores of large reservoir embankments were known to have been made. Mr. Rawlinson was no doubt a very good engineer in his way, but the nature of his Government position almost compelled him to be censorious. What he said went far with the public, but it counted for nothing with the engineering profession, the members of which judged for themselves.

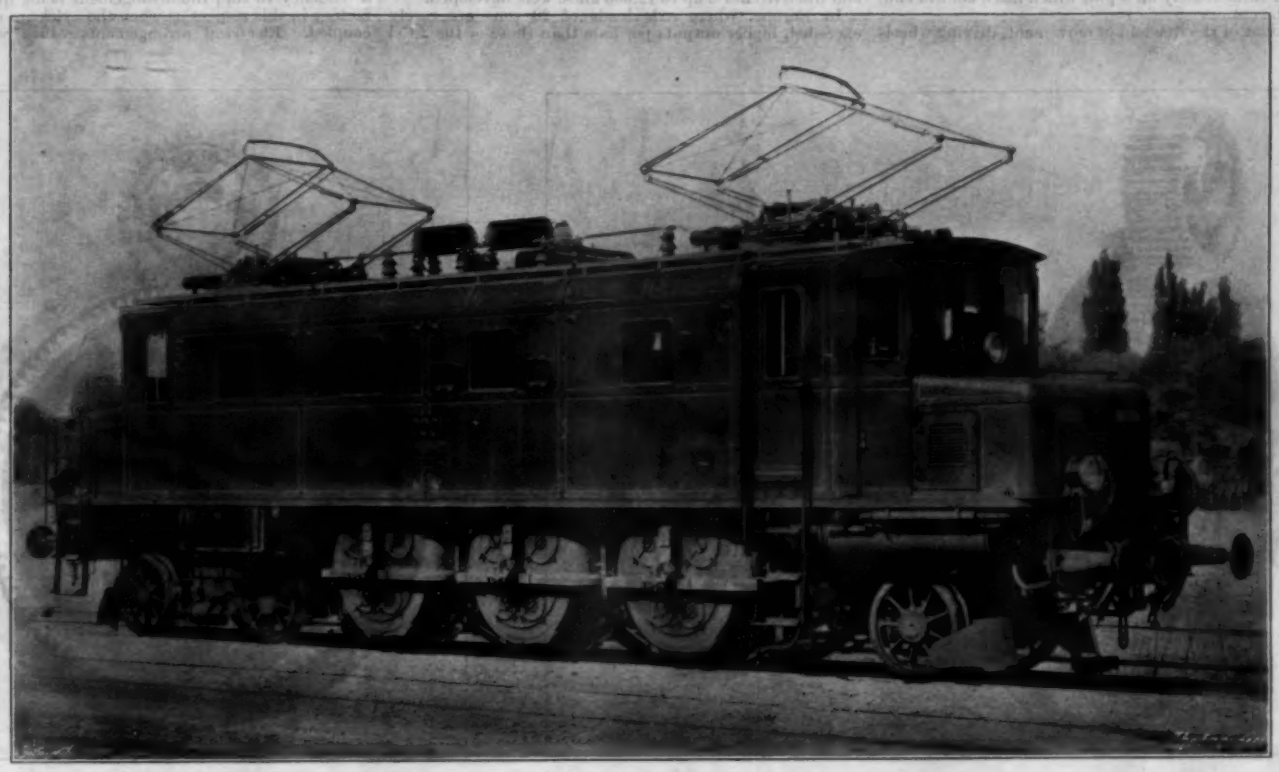
HEAVY OIL ENGINE INDICATOR DIAGRAMS.

At the March meeting of the Diesel Engine Users' Association, which was held on Friday last, Mr. J. M. Ferguson gave a paper on "Heavy Oil Engine Diagrams." In his paper the author gave an account of the different types of oil engine indicator diagrams and compared their characteristics. A further section of the paper deals with different factors and adjustments which affect the shape of the diagram and is illustrated by drawings of typical diagrams. The effect of the obliquity of the connecting-rod on the shape of double-acting and opposed-piston engine diagrams is discussed, and hints are given on the taking of indicator diagrams. We note that it is the author's opinion that whatever may have been the case in the past, there is now no necessity to purchase foreign-made indicators, as the British-made instrument is at least equal in design, workmanship, and finish to any any other make.

Commenting on the value of indicator diagrams, the author states that their real value is to assist the engine

2-C-1 SINGLE-PHASE ELECTRIC LOCOMOTIVE WITH INDIVIDUAL DRIVE

BROWN, BOVERI AND COMPANY, BADEN, ENGINEERS



user in diagnosing any irregularity occurring in the operation of the engine. Indicators are useful in ascertaining the compression pressure and the maximum pressure in the cylinder and the equal development of power by each cylinder in the case of a multi-cylinder engine. Apart from these points, the particular shape of the diagram is not, Mr. Ferguson says, of importance, provided the exhaust is clear. The colour and beat of the exhaust is a good guide to the running of an engine. If the exhaust is colourless and the beat regular there is little at fault. The facility with which an engine starts, its general running and temperature, the temperature and amount of cooling water used, and the temperature of the exhaust are useful points to note. It is when one or more of these guides show that something is out of order that the real value of the indicator becomes apparent. Dealing with the accuracy of results worked out from diagrams, the author points out that unless special precautions are taken the accuracy of the mean effective pressure or the indicated horse-power cannot be expected to be nearer than, say, of the order of 1 per cent. If this view is taken, it means, according to the author, that figures based on calculated values of the indicated horse-power, the mechanical efficiency of the engine, and amount of fuel consumed per indicated horse-power cannot be considered more than approximations and should consequently not be taken too seriously.

INSTITUTION OF MECHANICAL ENGINEERS.

LONDON SUMMER MEETING, 1924.

It is anticipated that a large number of engineers, with their ladies, from overseas and the provinces will visit London this year in connection with the British Empire Exhibition at Wembley, and the Council of the Institution of Mechanical Engineers has therefore decided that the summer meeting of 1924 shall be held in London and shall be occupied principally by visits to the exhibition, in accordance with the following provisional outline programme (subject to revision).

Monday, July 7th.—Evening: Dinner at the Connaught Rooms (ladies included).

Tuesday, July 8th.—Morning: Assemble at the British Empire Exhibition. Reception by the president, followed by luncheon in a restaurant near the Palace of Engineering.

Wednesday, July 9th.—The whole day will be spent at the exhibition.

It will be seen that the Council is proposing to depart this year from its usual practice of arranging for the reading and discussion of papers at the meeting. This decision has been come to in view of the numerous engineering and other conferences which will be held in London in the summer. Applications have already been made for the issue of reduced-price return railway tickets to London from all stations in Great Britain and Ireland.

The Institution of Electrical Engineers.—The following is part of a new by-law of the Institution of Electrical Engineers, which was adopted at a special general meeting of the corporate members held on February 28th, 1924, and was allowed by the Lords of his Majesty's Most Honourable Privy Council on March 20th, 1924:—"Every member and associate member is, and is entitled to describe himself as, a chartered electrical engineer, and in using that description after his name shall place it after the designation of the class in the Institution to which he belongs, stated in accordance with the following abbreviated forms, namely, M.I.E.E. or A.M.I.E.E., as the case may be."

PROPOSED NEW RAILWAY IN CHILE.

The proposed railway from Valparaiso to Santiago *vid* Casa Blanca, so often brought up for discussion only to be allowed again to sink into oblivion, is once more to the fore. Experts who have for some time been considering the feasibility of this new line report in favour of the construction of an electric railway of the same gauge as the State line connecting Valparaiso and Santiago. The new line is to pass through Casa Blanca and will possess two branches, one of which will connect with Mellpilla, thus shortening the distance between Valparaiso and the newly developed port of San Antonio. The second branch will run to Talagante, thus linking with the Central line to Santiago at Paine. Recommendations are made that this line should be constructed on an electrical system similar to that nearing completion on the present route from Santiago to Valparaiso. The President is understood to support the idea of beginning work as soon as possible and, therefore, it remains only to convince a few of the obstructing Senators to secure the requisite majority to carry out the project. The parliamentary representatives of Valparaiso are practically unanimous in their support of the undertaking, and it is hoped that, if, as seems likely, the Legislature can agree to it in the next session, the near future may see negotiations with foreign industrialists for the commencement of work on this route, now so essential as a further outlet for the populous city of Valparaiso.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

The Council of the North-East Coast Institution of Engineers and Shipbuilders has decided, in association with the Institution of Naval Architects and the Institution of Engineers and Shipbuilders in Scotland, to hold a summer meeting in London from June 24th to 28th next. The following preliminary programme of the meeting has been prepared:—

On Wednesday, June 25th, the meeting will be opened by the Duke of Northumberland (President of the Institution of Naval Architects), and in the morning there will be reading and discussion of papers in the Great Hall of the Institution of Civil Engineers. In the afternoon, a trip on the river Thames, to visit the docks and shipping of the Port of London, will be made.

On the Thursday, June 26th, a visit will be paid to the British Empire Exhibition, where there will be a luncheon given jointly by the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders. In the evening a reception will be held.

On the Friday, in the morning, there will be reading and discussion of papers at the Institution of Civil Engineers, in the afternoon a reception by the Duke and Duchess of Northumberland, at Syon House, and in the evening a concert and supper.

In connection with the meeting the following visits are proposed:—Saturday, June 28th, alternative visits to places of interest near London; Monday, June 30th, and Tuesday, July 1st, visit to Glasgow and the Clyde District; and Wednesday, July 2nd, visit to Newcastle and the Tyne District. The above programme is subject to alteration.

Single-phase Locomotives.

Most of the single-phase locomotives built by Brown, Boveri and Co. for the Swiss Federal Railways have a side rod drive, but experience has shown that this arrangement is not always entirely satisfactory from the point of view of smooth running. The firm's new 2-C-1 locomotives are built on different lines, each of the driving axles having independent motors—as shown above. The gearing is fitted on one side of the engine and the driving wheels on the opposite side are free—as shown in Fig. 1. It will be gathered that the leading part of the locomotive rests on a four-wheel bogie, whilst the trailing end is mounted on a Bissel truck. When travelling with the bogie leading, these engines have been found to run somewhat more smoothly than when the Bissel truck is leading. For the prescribed maximum speed of 90 kiloms. per hour, however, one leading axle is sufficient. The engine shown weighs 91.5 tons, there being 20 tons on each of the driving axles and 15 tons on each of the guiding axles.

In order to keep down the weight, only one transformer is employed, as shown in Fig. 3, and that is one of the reasons why the locomotive is asymmetrical. As it was impossible to place the transformer between the main motors on account of the driving wheels, the transformer constitutes the greater part of the load carried by the bogie. The gears and coupling devices also cause the locomotive to lack symmetry, but by using three pairs of driving wheels, to which the power is transmitted on one side only, the engines are considerably simplified, and their weight is reduced.

The load on each driving axle is, in fact, over 1 ton less than it is when the side rod drive is employed. The uniform distribution of weight about the longitudinal axis—*i.e.*, the axis about which the spring-borne portion of the locomotive can rock—is secured by placing the various pieces of electrical apparatus on the side opposite the gearing, and this arrangement also facilitates the inspection of the electrical equipment. The high centre of gravity of the motor and other electrical gear gives the locomotive a large moment of inertia, with regard to the longitudinal axis, so that smooth running is ensured at high speeds. By placing the gearing outside the frames, the space between the wheels is kept free for the motors, whilst at the same time a greater width is allowed for the gearing than is usually permissible.

The gear, which is connected to the driving wheel by means of the special coupling device shown in Fig. 2, allows movement in all directions, so that a certain displacement of the driving axle with respect to the locomotive frame can take place freely in a vertical and in a lateral direction, and the wheels can adapt themselves to curves. This coupling device enables locomotives having a single frame to be built with an exceptionally long wheel base, or a guiding and driving axle to be constructed, so as to form an articulated truck. Moreover, the coupling transmits the torque of the gear to the driving wheels at a constant angular velocity. The gearing is very liberally dimensioned, and the diameter of the pinion R—see Fig. 2—is large enough to enable springs to be placed between the rim and centre to protect the driving mechanism. The construction of the coupling device is very simple. Relative movements of the gear wheel Z and driving wheel T can take place without restraint, and the freedom with which the coupling can adjust itself when the spring-borne portion of the locomotive rises and falls in relation to the frame is a property which the makers contend few couplings possess. The device consists of a system of levers placed inside the rim of the gear wheel. Two pins A A fixed to the driving wheel T engage with the coupling-

rods B B, the forked ends C of which being connected to the geared segments S S, and the entire system is capable of transmitting the torque from the gearing to the coupled wheels. Moreover, the pins A A are spherical, so that sufficient freedom of movement is assured for all practical purposes between the driving wheel and the gear wheel. The latter turns loosely on a pin, which has a conical end, let into the casing.

On account of the freedom of movement, driving wheels mounted on the same frame, and having tires of different thickness, can be allowed for, and when the tires wear unequally it is unnecessary to lift the locomotive in order to remove all the wheels and renew the tires. If a breakdown occurs on one of the motors or gearing no delay is entailed, as the coupling device enables the driving wheels to be disconnected from the gearing with very little trouble. Special attention has been paid to the lubrication of the gearing and the bearings. A mechanical lubricator, driven from the gear wheels, forces the oil to the various parts where it is required, and after it has been used for lubricating purposes and has been purified in filters, it returns to the oil tank. This system, which is completely automatic, naturally does away with the periodical filling of oil cups, and tends to reduce the cost of upkeep. Briefly the advantages claimed for the Brown, Boveri individual drive are:—(*a*) The stresses on the bearings are diminished on account of the elimination of the alternating thrust on the coupling-rods, special devices for taking up the play in the bearings and coupling-rods being unnecessary; (*b*) there are no tendencies to vibration; (*c*) the gearing can be liberally proportioned without detriment to the motors; (*d*) the distribution of the spring-borne weights is such that their moment of inertia with regard to the longitudinal axis of the locomotive is exceptionally great, and this ensures steady and smooth running on straight track and on curves; the frames are light and exceptionally strong, as no holes have to be drilled for the motor and jack shaft bearings; (*f*) as each pair of driving wheels can have side play, and, if necessary, a certain amount of radial adjustment, the wear of the flanges is exceptionally small, and the wear and tear on the track is also reduced; (*g*) driving wheels belonging to the same group and having tires of different thickness can be allowed to run without inconvenience; (*h*) each motor can be quickly uncoupled without difficulty whilst the engine is on the railway, and (*i*) the complete automatic forced lubrication of the running parts and the filtering of the oil enables a great deal of time to be saved. A pair of wheels with the flexible drive are shown in Fig. 1, whilst views of a 2-C-1 locomotive with the sides removed to show the electrical equipment are given on page 362.

The rotor shaft is supported at three points, and the third bearing is outside the pinion, see the lower view, page 362, so that the pinion is supported on both sides. The meshing of the teeth is facilitated, as the outside bearing and the pin of the gear wheel can be carried by a common support which is built with the locomotive body. Moreover, the individual axle drive allows the frames to be made exceptionally rigid, so that no fear need be entertained of the journals of the gear wheels and pinions seizing as the result of the locomotive bending. Three years' experience has failed to reveal the slightest deformation of the frames, which are very robust. The provision of a third suspension point for the rotor shaft enables the bearings and shaft to work under most favourable conditions and obviates wear. Compensation beams, which unite the springs of the driving axles, serve to equalise the load. The whole of the spring-borne portions of the locomotive rest on the wheels at three points on the longitudinal axis, and the truck axles have two sets of springs. For supplying the sand to the rails an air blast apparatus is fitted on each side of the driving wheels, and openings in the locomotive body enable the sand boxes to be refilled with ease.

The individual drive permits very high outputs per driving axle. Each motor on the 2-C-1 locomotives is rated at 700 horse-power at 500 revolutions per minute on the 1 hour basis. There is, however, ample space on these locomotives for motors of considerably higher outputs. A train weighing 480 tons can be hauled by one of the locomotives shown, and having a capacity of 2100 horse-power at a speed of 90 kiloms. per hour up a 1 per cent. gradient, or at 65 kiloms. per hour on a 2 per cent. gradient. During a test one of these locomotives started and hauled a train with 120 axles and weighing 722 tons up a 1 per cent. gradient without the slightest difficulty, and tractive efforts up to 12,000 kilos. were developed.

In Europe, where axle loads of 20 tons are rarely exceeded, higher outputs per axle than those of the 2-C-1 locomotives are not required; but in America, where loads as high as 30 tons per axle are adopted, on certain railways motors rated at 1000 horse-power per axle could be utilised with the individual drive. The individual drive is specially adaptable to express passenger locomotives, which have to be capble of travelling at high speeds, and which have high outputs per axle; but it can also be used for goods service. During three years an experimental 1-C-1 locomotive of this type was in use and Thun. Since March, 1922, one of the engines has been hauling express trains on the St. Gothard section of the railway.

Experience gained in practice and special tests made to determine the extent to which slipping occurs are said to have shown that this form of drive does not produce a tendency to slip, the arrangement being quite as satisfactory in this respect as when the axles are mechanically coupled. Electrical arrangements which were at first provided for causing the driving wheels of the 2-C-1 locomotive to rotate at the same speed were, consequently, removed, as they were found to be unnecessary. Provided the springs are correctly proportioned and the moment of inertia of the portions of the locomotives which can oscillate is made sufficiently large, no harmful effect need be produced by vertical shocks. The individual drive enables the driving axles to be given a certain amount of side play, and also allows all the axles to be mounted on a common frame. The arrangement also allows the axles to move to and fro laterally without having the slightest effect on the frames or the spring-borne parts of the engine. Inequalities of the track, which are liable to produce lateral shocks, are felt exclusively by the driving wheels.

On entering curves the frame of the engine is guided by the leading axles, which are coupled to the frame by means of springs, and owing to the lateral play of the

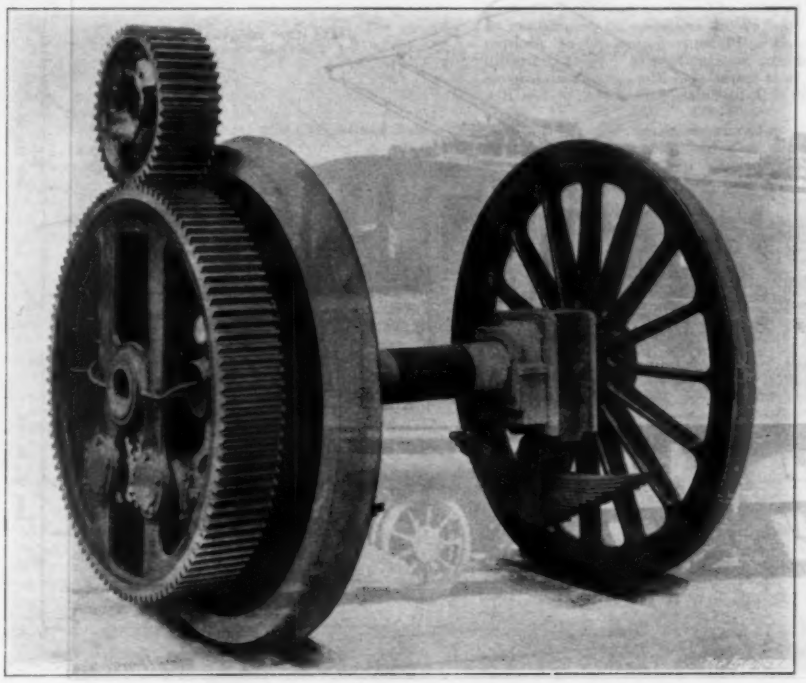


FIG. 1—DRIVING WHEEL WITH FLEXIBLE GEAR DRIVE

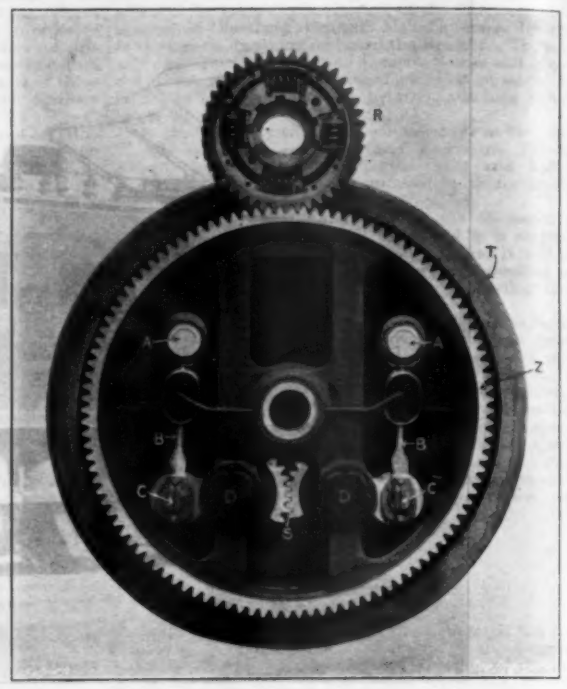


FIG. 2—FLEXIBLE COUPLING DEVICE

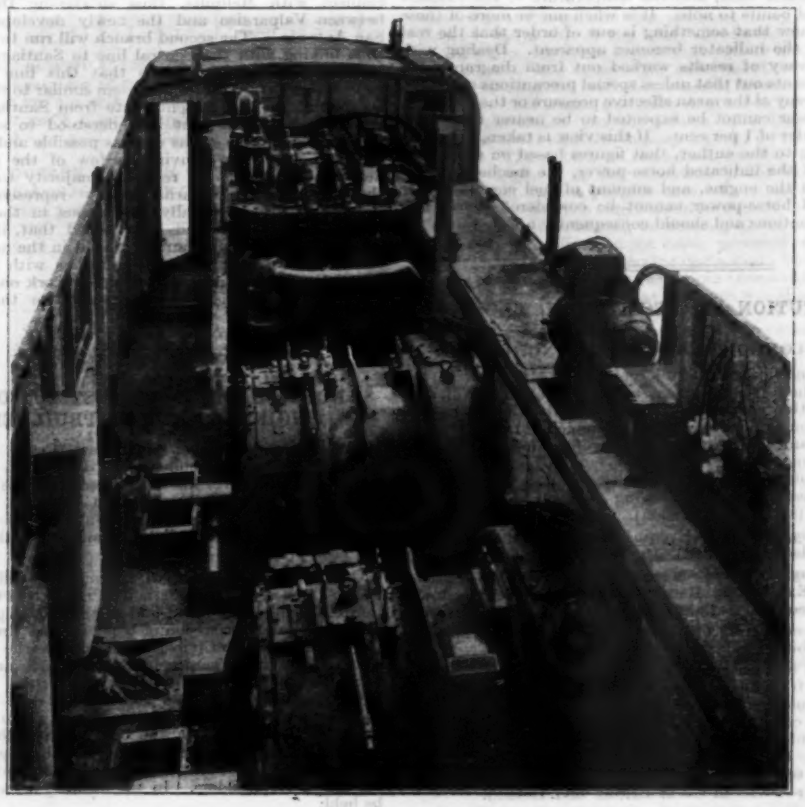


FIG. 3—LOCOMOTIVE WITH TOP REMOVED

no bearings had to be adjusted or renewed, and not a single tire had to be re-turned. Moreover, the driving mechanism did not show the slightest trace of wear. The favourable results obtained with this experimental engine led the Swiss railway authorities to order eight 2-C-1 engines built on the same lines, the first being completed at the beginning of August, 1921. These engines are intended for heavy express passenger service, and they are at present working regularly between Berne

driving wheels, the flanges are pressed against the outer rail. The Brown, Boveri individual axle drive is, therefore, claimed to be suitable in all respects for express traffic, and it runs perfectly smoothly at high speeds, both on straight and curved portions of railway track.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

THE quarterly meeting of the Midland iron trade was held at Birmingham to-day—Thursday—when there was a large attendance of representatives from all parts of the country, including a good contingent from South Wales. The market tone was fairly bright, taking everything into consideration, but the volume of business which passed, though greater than has been the case at the last few meetings, was nothing like so large as is generally expected from a gathering of this character. Confidence is, unfortunately, still lacking, and anxiety prevails with regard to the troubles which appear to be brewing in the coalfields, and in the engineering and allied industries. If these could be satisfactorily dealt with, it is thought there would probably be a definite reinvigoration of the market. In spite of the disturbing effect of the miners' wage crisis, however, a moderate amount of business was carried through in the iron and steel trade. Orders were for the most part restricted to the supply of current needs, but some forward contracts were reported to have been made, though the uncertainty of fuel prices and the labour outlook remain serious obstacles to enterprise. Orders were carefully taken, the general expectation being that the wages settlement will increase the fuel bill. Complaints were general as to the scarcity of fuel, some of the Staffordshire works finding operations difficult, even with the present restricted scale of activity. Midland manufacturers are worried because they are getting daily reminders that they cannot hope to succeed against their foreign competitors unless they keep prices down, and the producers of raw material have already reduced their prices in many branches below an economic level, in order to start a new trade movement. If production costs are to be increased, the difference must in the majority of cases go on to the selling price. That can only mean a curtailment of the market, with a reversal of the favourable trend of unemployment. How favourable that is may be seen from the fact that during the quarter the unemployment returns in the Midlands area have decreased by over 20,000. That is a large absorption of labour, and proves conclusively that the industries of this district are considerably better off for work than was the case at the beginning of the year.

Trade Prospects.

The opening of the second quarter fortunately finds the numerous Staffordshire and Midland industrial concerns with a satisfactory volume of business on hand. Railway contracts and the requirements of constructional engineers are keeping steel makers moderately employed. The condition of the mechanical and electrical engineering trades continues to show slight improvement, while makers of small tools are well employed. On the other hand, no appreciable improvement can be recorded in the machine tool trade. Steel works are, however, gradually exhausting their contracts, although they are not yet actually in difficulties for want of business. The orders lately placed by the railway companies for rails and other material are in nearly all cases for deliveries over long periods, typical examples being 1000 tons per month for various destinations. The steel works require orders to supplement these contracts if mills are to be kept in regular employment. After a spell of dullness, the past fortnight has produced an improvement in the demand for Midland brands of pig iron. This is partly due to the receipt of several substantial orders from the Continent, and partly to the increased call by engineering firms for foundry iron. South Staffordshire ironworks continue to find business very difficult, and prospects for the immediate future are none too bright. Continental competition is extremely severe, especially as regards nut and bolt iron, and though Belgian quotations have stiffened during the past three weeks, they are still so low that sellers can get all the business they want, leaving a very small portion available for Staffordshire makers. Lancashire houses which quote from 5s. to 10s. more per ton than local makers are out of the market, but they refuse to budge from the stand they have taken. The greater portion of orders for the nut and bolt works is going to the Continent, and makers here can see little likelihood in the near future of preventing a continuance of this state of affairs.

More Work.

Midland firms figure in the latest list of contracts given out by the Government, and the work is very welcome. Messrs. Guest, Keen and Nettlefold; Harrison and Cook, Birmingham; J. Sankey, Bilston; and Walls, Limited, Birmingham, have secured orders from the Admiralty; while Miller and Co., Limited, Birmingham; John Shaw and Sons, Limited, Wolverhampton; Elliott's Metal Company, Limited, Selly Oak; and John Wilkes, Son and Mapplebeck, have orders on hand for the War Office. Tubes, Limited, Aston, have secured a contract for boiler tubes from the Crown Agents for the Colonies. Several Black Country firms have received contracts from the London, Midland and Scottish Railway Company for supplies of materials; while Bayliss, Jones and Bayliss, Limited, have been successful in obtaining contracts for iron fencing for the London County Council, Margate Town Council and the Urmston (Lancs.) U.D.C.

Steel Position.

The fall in finished steel prices was probably one of the most discussed matters at to-day's quarterly meeting. The withdrawal of price control of steel bars was promptly followed by a reduction in selling rates to £9 15s., ranging up to £10 per ton. On 'Change in Birmingham to-day the lower figure was freely quoted, though its continuance must depend upon deliveries of cheap Belgian billets. To meet the competition of unassociated and foreign firms, steel masters in many instances to-day accepted £9 15s. per ton for angles, £10 15s. for tees and £9 15s. for joists, though in view of the narrow margin of profits steel makers who are well placed adhere to the £10 figure for sections. Some very low prices were quoted on export business, especially for joists. Figures as low as 25s. per ton below home quotations were heard of. Re-rollers of steel bars, sections, &c., appear to be in a fortunate position just now. One large firm, which has been doing excellent business for a year now, has secured some very considerable railway orders for steel bars and sections for carriage building and general construction work. Apart from this, however, inquiries are not quite so good as they have been, and the orders are dropping off a little, owing, it is believed, to the industrial outlook. There is some relaxation in foreign semi-finished steel competition. Belgian billets are not now flooding the market, and values are invariably higher, with £7 as the minimum. Many quotations, however, are well above this, and at to-day's meeting, where orders were accepted, it was only at higher prices than those recently ruling, £7 5s. being the figure most mentioned. English billets can be bought at £8 per ton minimum, but many firms want up to £8 10s., and if rollers are driven to use these in any large proportion, it must inevitably react on the price of their products. Consumers have, however, bought heavily of continental billets, and have lately obtained better deliveries. But there is still a lot of material to come in, and there are widespread complaints as to transport difficulties. Delays are numerous, and heavy tonnages of foreign steel are still awaiting delivery. It is difficult also to get consignments from English steel works of finished material, especially where the steel is of extra length, the necessary vehicles for conveyance of such material being deficient. Following unusual delays, strong representations have been made to the railway managers with a view to the supply of additional rolling stock.

Staffordshire Finished Iron.

Business is generally dull in the Staffordshire finished iron trade, marked bar mills, however, being an exception. Leading makers of best iron have been during the quarter, and still are, making full time at the recognised figure of £14 10s. For unmarked bars, prices show considerable variation. Bars of Crown quality are a better market than they have been of late. A few favoured firms can maintain the £12 10s. price, but in many cases 5s. less is accepted, and even lower prices have been mentioned. Nut and bolt bar producers are suffering severely from the activity of Belgian competitors. Some Staffordshire makers are standing out for £11 15s., which they say is as low as they can go in view of high production costs, but others intimate their willingness to accept half-a-crown less. Lancashire houses adhere firmly to a £12 minimum, delivered in the district, but that figure is by no means in accordance with the views of users. Belgian bar iron, which is quoted about £8 12s. 6d. to £8 15s. delivered here, has a large sale, and there is not a great deal of business left for the Staffordshire and Lancashire producers when continental houses have taken all they require. A bright feature is the activity of tube mills, and a substantial volume of additional business was booked prior to the recent 2½ per cent. reduction in the discount. This improvement in the tube trade has stimulated the demand for iron and steel strip, and it is expected to expand still further. Most sellers of wrought iron gas tube strip at to-day's meeting wanted £13 per ton, but there were a few who for good orders accepted £12 17s. 6d. This price is an advance of from 7s. 6d. to 10s. per ton on the figure ruling at the beginning of the quarter.

Raw Iron Improvement.

The raw iron department shows some improvement, pig being in much better request at to-day's quarterly meeting. There was a notable increase in the demand for foundry iron for engineering firms, and a few consumers seemed prepared to place forward contracts. Forge iron sold in moderate quantities. Values of Midland brands of iron remained steady. Northamptonshire makers booked substantial business for delivery over two or three months, and were firm in their quotations of £4 12s. 6d. for No. 3 foundry, and round about £4 5s. for forge. Derbyshire No. 3 foundry was based on £4 15s. at furnaces, and forge on £4 7s. 6d., rising to £4 10s. in special cases. North Staffordshire makers quoted forge £4 7s. 6d. upwards, and foundry £4 15s. The high price of fuel is partly accountable for the firmness of prices, for, notwithstanding the confirmation of coke values at 24s. per ton at ovens for the next five weeks, there is still some anxiety as to future values. Exports are declining rapidly, but coke makers are stated to be disposed to lessen the output to prevent substantial reduction in selling values.

Galvanised Sheets.

The home demand for galvanised sheets is quiet, and prices have fallen by from 10s. to 15s. per ton during the past quarter. At to-day's meeting 24 gauge corrugated sheets were sold at £18 to £18 5s. per ton, both for home and export consumption, whereas at the January quarterly meeting they commanded £18 15s. to £19. The export department has picked up a little during the past week. Black sheets are in excellent demand and remain firm.

Scrap.

Moderate business is being done in steel scrap at prices ranging between £4 5s. to £4 10s. per ton. Wrought iron scrap is in good demand, and commands from £5 to £5 5s. per ton.

Ironworkers' Wages.

The bi-monthly ascertainment under the Midland Iron and Steel Wages Board, published this week, shows that as a result of an increase in selling values the wages of puddlers in this district, under the sliding scale which regulates wages, will be advanced from April 7th to June 7th by 5 per cent., bringing them up to 60 per cent. above the base rate of 13s. 6d.

Unemployment Decrease.

Following upon the decrease noted in this column last week of 3976 in the number of unemployed in the Midland area, comes this week a further substantial decrease of 4801, bringing the total number of workless down to 124,745, which is over 20,000 less than at the beginning of the quarter. In the Birmingham area the week's decrease is 1833; Coventry, 50; Bilston, 76; Cradley Heath, 206; Oldbury, 53; Smethwick, 112; West Bromwich, 10; Wolverhampton, 211.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE general condition of the iron and metal markets here does not yet show much change for the better. Demand is very slack all round, and any revival of trade is hindered by the very unsettled condition of labour. It seems almost certain that there is to be an epidemic of strikes this year, and it is very difficult to see what is to be the outcome. The urgent need of the nation's industries is for lower prices and cheaper production if we are to keep our foreign trade, whereas the prospect is for higher prices and dearer production; or if prices are kept down then it will be because production is being carried on at a loss. There are rumblings in the engineering industry suggestive of an attempt to increase wages; and this is not surprising, because skilled engineers are in many cases worse off in the matter of wages than many workmen in other less exacting industries; yet the engineering industry is in no condition to pay higher wages.

Metals.

The markets for the non-ferrous metals have been in a rather wobbly condition for some time, and it is by no means clear what is going to happen. Consumers for the most part are in a hesitating mood, and perhaps for some time we may see a period of hand-to-mouth buying. With the exception of lead, however, one cannot say that there is much danger now in holding fair stocks of metal. Copper is certainly at a very moderate price, and although there may be fluctuations it is difficult to believe that prices can be much lower. It is noticeable that the prices of manufactured copper and brass have been kept practically on the same level during the fluctuations of the last fortnight; as if makers were convinced that the setback which followed the collapse of the speculation in French currency was purely a temporary movement. The movement to reduce production of copper in America is being arranged, but it is not possible yet to say to what extent the reduction is to be carried. Nevertheless, now that consumption is slowly improving a moderate check to the American output ought to have a stimulating effect on the prices, or, at any rate, to prevent any further return to very low values. It cannot be questioned that copper is relatively cheap, and it only needs a renewal of confidence to bring much more activity into the market. It is generally believed that consumers, both here and in America, but especially in the latter country, are not well provided with metal, and if this belief be true, the market must be regarded as comparatively healthy. The great irregularity in the market for tin is very trying to merchants, who scarcely know from day to day what to quote for small lots, such as are sold in this district. Of course, Manchester is not a speculative centre for tin, and the legitimate business is very difficult; but it is noticeable that the selling agents for producers are very confident that sooner or later the market will get back to a much higher level of prices, even if it does not reach the £300 which was so nearly attained before a recent slump. The actual consumption of tin continues to be large, not only in tin-plate making, but in other industries; but no doubt many people have received a severe shock from the movements of the last three weeks, and it may take some time to re-establish public confidence in the metal. The market for lead seems to be slowly recovering, and although the recent extreme price may not be again reached, there is not much chance yet of really cheap metal. It is said that some increase in production has begun, but this is probably trifling so far. Spelter is in a steadier condition, but the consumption of the metal in the home industries seems to be a little smaller than it was.

Pig Iron.

The market here for foundry iron is thought to be a little better. One notices rather more confidence in the prices, and no doubt this is caused by the stoppage in the fall of Cleveland prices. Consumers of foundry iron here had been relying upon the fall in Cleveland to force the Midland makers to accept something under 95s. per ton on trucks; and now it would seem that the prices in the North-East will not become sufficiently low to compete with Derbyshire foundry iron in Manchester. The result may very easily be freer buying of Derbyshire iron in the Manchester district; and the furnaces are not yet in a position to be unduly anxious to secure orders. There has not been yet any very marked improvement here in the demand for castings, but, of course, there is some new business, and the ironfounders have, for the most part, kept out of the market for so long a time that they cannot have very large reserves of pig iron in their yards. Undoubtedly a good business could now be done if sellers were prepared to make small concessions, but one does not see any disposition yet in that direction. The price of No. 3 iron in Manchester is steady to firm at 102s. 6d. per ton delivered for Derbyshire and Northamptonshire, 103s. 6d. for Lincolnshire and 105s. for Cleveland. The cost of Scotch iron here is 113s. to 114s. per ton.

Steel.

The market for manufactured steel remains weak and irregular. The withdrawal of price control

has not yet made much difference, partly because the selling prices are close up against actual costs, if not in some cases below the cost of manufacture. Sections are usually quoted here at £9 12s. 6d. to £9 15s. per ton; although one would not like to say that it was impossible to buy at £9 10s. Ordinary qualities of steel plates have been heard of in Manchester at £9 15s. per ton, although £10 is a more usual price. The demand for plates, however, is very poor. The large discrepancy between British and continental prices has been somewhat lessened lately by the rise in the franc, and it is possible that actual competition by foreigners in our home markets may decline; but there is not much chance of large export business unless at a serious loss to the British manufacturer. For export £8 10s. has been quoted for joists and angles, and it is very difficult to see how any profit can be squeezed out of that figure.

Scrap.

The markets for scrap materials are all very dull, but there has been no further distinct fall in the prices here. Dealers are rather inclined to hesitate about paying 75s. on trucks for heavy melting steel scrap, and some of them offer now only 70s. per ton on trucks at a Lancashire station. The only practicable market is Sheffield, and buyers there are very indifferent. For heavy wrought scrap from 95s. to 100s. is the price delivered to the consumers' works. Cast scrap remains quiet, but fairly steady at from 85s. to 92s. 6d. per ton, according to quality.

BARROW-IN-FURNESS.

Hematite.

The position in the hematite pig iron trade in this district has weakened considerably. The Barrow steel works, which closed down a little over a week or so ago, placed the iron works in the position of making more iron than was required and, as a result, both furnaces at Barrow have been damped down and thus, as far as Barrow is concerned, matters are almost at a standstill. Generally speaking, trade is worse than it was. There seems to be a complete lack of confidence on the part of buyers who are only taking iron for immediate requirements, and are in no way inclined to commit themselves for forward delivery. Quite apart from the possible trouble with the miners, which was quite bad enough, the threatened lock-out of the shipyard workers has added another cause for hesitation. All the iron which is being made at the present time is not sold and some is going into stock. A few merchants have been inclined to accumulate stocks, but have not been willing to go very far as regards tonnage. Until there is some solid ground to stand upon as regards the labour outlook business is likely to continue to be bad. The continental trade is small, and that with America does not bulk at all. The fact that there will in the early future be direct shipping communication between Barrow and Philadelphia leads one to think that the American business might improve to some extent.

Iron Ore.

The iron ore trade is dull and in the Furness district there is very little being done at all. In Cumberland the Hodbarrow Company has restarted, but the amount brought to the surface is limited. The business done in foreign ore generally, and Spanish particularly, is naturally very small in view of the stagnation in the iron trade.

Steel.

The position in the steel trade is bad, and the present signs are not very encouraging. The Barrow rail and merchant mills are idle and there are no signs of restarting yet. The position in West Cumberland is a little better, but the future is not bright at present. The hoop and small section mills at Barrow have work to keep them going, and there is no likelihood of there being any stoppage in this direction.

Shipbuilding and Engineering.

The competition for the cruiser contracts to be given out this week is very keen. Barrow is hoping that an order will come its way and, if it does, it will be very welcome. There is no news of any further orders being booked at Barrow, but in the early future there is some possibility of an announcement.

SHEFFIELD.

(From our own Correspondent.)

Condition of the Steel Trade.

THE steel trade is somewhat busier, and is finding employment for more men, but whether it is any more prosperous is questionable. Recent reports of local companies have been anything but cheering reading, and it is currently believed that many firms are working without profit, an impression that gains strength from the fact that the shares of several leading concerns have been falling in price. At the same time, activity is certainly more manifest in some directions. At the works of Samuel Fox and Co., Stocksbridge, all the seven Siemens furnaces are in commission, for the first time since the boom year of 1920. Generally speaking, the basic side of the trade shows no improvement. Local makers of billets are consuming an increasing quantity of material in their manufacturing departments, but are booking few contracts, and those only for small lots. There is very little inquiry for pig iron on forward account. Prices of billets are said to be easier, but, as they are already unremunerative, makers cannot reduce official quotations.

Some Busy Departments.

The acid side of the heavy steel trade continues to expand, largely owing to the requirements of the railway companies. The motor industry is also making large demands for stampings and various parts. It is from these two sources chiefly that the improvement in trade has come. The general engineering and shipbuilding trades are not sending much business forward, and the demands from continental countries continue on a small scale. A good trade is being done in pipes on home and export account, which is keeping ironfounders busy, but they are only moderately employed on castings for the building trade and are quiet in general lines. A satisfactory line is that of cold rolled strips, for which the demand is well maintained, and good time is being worked at the mills and forges. The crucible steel trade remains in a very unsatisfactoy condition. True, there has been some improvement as compared with a year ago, but, so far as the majority of the makers are concerned, progress is painfully slow. A disquieting feature, which has just been made public, is the fact that a further thousand tons of surplus Government steel, produced during the war, recently made its appearance. It is the existence of huge stocks of this material that has largely been responsible for the slump from which the trade has suffered ever since the Armistice, and it was thought that the stocks had at last been cleared out. The discovery of this new reserve came as a shock. The Sheffield manufacturers themselves bought back a good deal of surplus steel from the early parcels, but when this last lot was offered they could not afford to buy it, and the bulk of it went to America at scrap prices. Mr. William Clark, ex-president of the Sheffield Chamber of Commerce, who made this statement, added that some of the crucible furnaces in Sheffield had not produced a ton of steel during the last twelve months.

Progress of Cold Rolling.

Of late years there have been great developments in the manufacture and use of cold rolled strip. The production of the material was largely in the hands of the Germans before the war, but now the industry is an important one in Sheffield and district, and the local products have a high reputation. The extent of the application of cold rolled strip has grown very rapidly, new uses being discovered for it almost every week. One of the firms engaged in this branch is that of J. and J. Habershon and Sons, Limited, Holmes Mills, Rotherham, and its monthly magazine gives some interesting information as to their activities. It states that since the beginning of the year a few pairs of rolls have been started in the new cold rolling mill, together with a pickling machine, and it is hoped that the whole of the mill will be ready before long. A continuous annealing furnace is under construction in the same building, and it is intended to deal with the product of the mill. The construction of a new paring and slitting shop, adjoining the furnace, has been begun. The new plant will relieve the congestion in the older shops of the cold rolling department, and afford an opportunity for remodelling some of them. The directors note an improvement in the quality and finish of the cold rolled strip since Mr. Brearley took over the management of the department. Speaking generally, the volume of orders in January and March was moderately good, and the prospects of full work for the mills in the immediate future are fairly good, although it is impossible to predict far ahead.

The Benefit of Railway Work.

The extent to which the railway companies' policy of renewals and extensions has contributed to the activity of the Sheffield steel trade was indicated in the speech of the chairman of Henry Bessemer and Co., Limited, at the annual meeting last week. He said that the firm's output of tires and axles last year was 100 per cent. greater than in 1921, and over 50 per cent. greater than in 1922. During the first three months of this year the output of tires was 40 per cent. greater than during the corresponding period of 1923. During last year the firm received orders from all the principal railway companies in Great Britain, from the India Store Department, the High Commissioner for South Africa, and the Egyptian and Sudan Government Railways; and the company was now on the Crown Agents' list for carriage and wagon tires. The company is at present handicapped by the want of modern plant at Sheffield. A policy of replacement is being actively pursued, and a large amount of money has already been spent in this direction. The works at Bolton are regarded as an encumbrance, and the directors are taking steps to close them down and dispose of the assets.

The Root of the Trouble.

Mr. W. L. Hichens, presiding at the annual meeting of Cammell Laird and Co., Limited—a company which was unable to pay any ordinary dividend in respect of 1923—made some significant remarks as to the causes of trade slackness in this country. While admitting that inflation and high taxation contributed to the difficulties of manufacturers, he considered that high wages were the chief reason for raising costs of production to a level which made competition extremely difficult if not impossible. Foreign trade, he said, was vital to this country, and if they were to retain it they could not in the long run pay relatively higher wages or maintain a higher standard than their rivals. "For," he went on, "we cannot obtain higher prices than they, and we have no advantages which they do not possess. It is, I believe," he continued, "the fact that wages per unit of output are higher in this country than on the Continent of Europe, and this is, in my opinion, the chief reason why we are unable to compete successfully. For competition cannot be called successful if it means that orders can only be secured at a heavy loss. If trade is to recover, labour must play its part and recognise that both as regards hours of work and wages it has to face foreign competition. And yet, as everybody knows, the tendency is for wages in this country to rise. The results of this will, I believe, prove disastrous."

Cutlery and Plate.

There is an improving tone in the cutlery and plate trades, but in certain directions only. At this period of the year visits from colonial buyers are usually expected, but so far very few have been received. It is thought that the buyers are probably delaying their journeys until the British Industries Fair and the British Empire Exhibition open. An improvement in the old-fashioned razor trade is reported. Some makers are of opinion that the safety razor is losing ground, to the benefit of the older type, which it has hit very hard in the past. At the same time, Sheffield continues to produce larger and larger quantities of safety blades, many of them being for the export markets.

Colliery Progress.

Lord Aberconway, presiding at the annual meeting of the Rossington Main Colliery Company last week, gave some interesting information with regard to the development of the colliery, which he said had proceeded satisfactorily during the year. The average daily output had risen, and the general condition of the pit might be taken as satisfactory. The Barnsley seam of coal continued to be excellent, and the working face was in good order. The total length of coal face now developed could yield 3000 tons per day, and as soon as sufficient men could be procured the daily output would reach that figure. The total raised last year was 140,000 tons more than in the previous year. The colliery plant was complete, and an adequate supply of electric current had been ensured for future requirements. They had now 700 wagons, and had made arrangements for another 300. At the meeting of the Firbeck Colliery Company, Lord Aberconway stated that in all his experience he had never seen anything so rapid as the progress of that pit since the first sod was cut. The start was made in June last, and the work had progressed so rapidly that they expected coal would be reached about June next year. At the Yorkshire Main Colliery, near Doncaster, a new washing plant, capable of dealing with 160 tons per hour, has been completed, and similar plant is in course of construction at Brodsworth, Hickleton Main and the new Markham Main Colliery at Armthorpe.

Gas Engineering.

An important development of the technical side of Leeds University has been inaugurated by the opening of an experimental coal gas plant, intended for research purposes, which has been presented by Mr. Henry Woodall, jun., in memory of his father, the late Sir Corbet Woodall, who was a leading figure in the gas world. The plant is provided with both horizontal and vertical retorts, and has cost nearly £4000. At York, in connection with the celebration of the centenary of the introduction of gas into the city, a new vertical retort installation has been opened at the works of the York Gas Company. Mr. G. E. Foxwell, of Sheffield, chief chemist to the Koppers Coke Oven Company, Limited, has been appointed chief assistant research chemist to the Gas Light and Coke Company, of London. The recent decision of Sheffield City Council to appoint a lighting engineer for the city has been followed by a recommendation of the Watch Committee that the post shall be given to Mr. John F. Colquhoun, who is at present assistant to the inspector of lighting at Glasgow. The appointment is worth £500 a year.

New Search for Oil.

Operations with a view to obtaining a supply of oil from Derbyshire are to be continued by the Duke of Devonshire, at Hardstoft, near Hardwick Hall. Among the sinkings carried out in Derbyshire by the Government a few years ago, the well at Hardstoft was the most prolific, and it is still yielding a supply of oil. The Duke has decided to sink a new well a short distance from the old one.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Revival.

THE condition of the iron and steel trade has undergone a material change for the better. There has been an encouraging renewal of activity on the market, and a most gratifying feature is the fact that there are inquiries for contracts to the end of the year. Thus the new quarter opens with decidedly improved prospects. The recovery of the franc has completely altered the situation abroad. French manufacturers can no longer compete with British producers, with the result that the stream of trade has been diverted from the Continent to England. During the past few days the demand has been such as to liquidate most of the stocks, and encourage the hope that ere long some of the idle furnaces will again be in action. Much, however, depends upon the outcome of the negotiations with the miners and the shipbuilding operatives. But if further industrial warfare is averted, the outlook will be brighter than at any period since the turn of the year.

Iron and Steel Exports.

The revival in the iron trade is reflected in the improved exports from Cleveland during the month of March. Compared with February, the shipments coastwise and foreign have been almost exactly doubled, the figures being—February, 16,471 tons; March, 32,427 tons. The latter figure, however, falls considerably short of the January total of 41,270 tons. Not since March of last year has so much iron been shipped to Scotland, the total for the month just ended being 11,573 tons. Belgium, with 5493 tons, was Cleveland's next best customer. Much of the iron shipped to Antwerp, however, is destined, not for Belgium, but for Germany and elsewhere, and this figure is therefore misleading. A steady trade continues to be done with the United States, and it is interesting to observe that for the last three months the shipments have been—January, 3430 tons; February, 3925 tons; March, 3825 tons. There was, however, a decline in the exports of manufactured iron and steel, the total for March being

48,010 tons, as compared with 62,199 tons in February. Foreign competition has been keen, but the decline is in some measure an aftermath of the dockers' strike. To India, Burmah and Ceylon the exports fell from 25,065 tons in February to 12,037 tons in March, and this is sufficient to account for the whole of the drop in the March figures. Shipments to South and East Africa also showed a decline. Trade with Australia and the South American republics showed a satisfactory advance. In the case of Australia and New Zealand, the total manufactured iron and steel shipments were 9174 tons, compared with 7891 tons in February, while to South America 4493 tons were shipped compared with 2228 tons in February.

Cleveland Iron Market.

A very firm tone now characterises the Cleveland pig iron market, and values show a marked upward tendency. Recent sales have been on a very heavy scale, and perhaps the most encouraging feature of all is the strong continental demand. The fact is that Cleveland pig iron is now the cheapest iron available f.o.b., and the improvement of business is entirely due to this fact. Some of the makers have cleared out the whole of their stocks, and as the demand is still apparently undiminished, they have put their price for No. 3 G.M.B. Cleveland up to 95s. per ton. Sales, however, have not yet been reported at that figure, and indeed there are still holders of iron prepared to do business at 92s. 6d. No. 4 foundry and No. 4 forge are irregular, but the former may be put at about 91s. 6d. and the latter at 90s. 6d. There is very little No. 1 foundry iron available, and sellers ask up to 100s. per ton.

Hematite Pig Iron.

There have been some good sales of East Coast hematite also, but stocks are very large, and not all have yet been liquidated, although the position has materially improved. Some makers are still holding out for 100s. per ton for mixed numbers, but purchases can be made at 99s.

Ironmaking Materials.

The foreign ore trade is still in a very depressed state. Freights are stiff, but buyers are seeking to "bear" the market, and there is practically no business. Coke is a little firmer, good Durham furnace brands being about 30s. per ton delivered at the works.

Manufactured Iron and Steel.

The succession of strike threats and the fear of a shipyard lock-out is having a prejudicial effect on the manufactured iron and steel trade. All round the demand is quiet, and works are becoming anxious to replace orders which are now being completed. Still, there is no inclination to cut prices, which remain unaltered from last week.

The Coal Trade.

The protracted negotiations with the miners continue to upset the usual routine of the North of England coal trade, and, although operators hope that a settlement will be reached without recourse to a strike, they are endeavouring to take precautions by securing all available stocks up to the date of the notices. Consequently, any supplies offered for delivery over the first half of this month command full prices. The forward prospects are more encouraging. Business is on offer on extensive lines over the next few months, but, while buyers decline to pay the current maximum, they make counter offers at a reasonable discount, and it only wants an assurance that the coal output will continue satisfactory to encourage bookings on a considerable scale, and at prices which will be regarded as favourable, and certainly higher than appeared probable a few weeks ago. German and American competition is keen in all continental centres, but at or about the current prices British coals are favoured by the consumer. A very strong tone prevails in the Northumberland steam coal section. Collieries are well sold for some weeks ahead, and prompt supplies of all descriptions are difficult to secure. There is also a brisk state of affairs in the Durham gas coal trade, and there has been a steady appreciation in values. The market for gas coke is steady, and prices, though stationary, are well maintained. Patent oven cokes are ample to meet requirements, but the demand, though still dull, is slightly better and values are steady.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE tonnage launched on the Clyde during the month of March reached a total which compares well with pre-war statistics for the month. Within the period sixteen vessels, of 58,218 tons aggregate, were launched from Clyde yards, which is the highest return for the month of March since the end of the war. Unfortunately, this cannot be taken as representing a return to old activities, but really indicates the rapid completion of work which was held up during last year's shipyard dispute. The vessels launched ranged from a B.I.S.N. liner to a 7-ton motor launch. The liner was the Tairea, twin-screw, 9200 tons, passenger and cargo. Other vessels of interest included the following:—Cariboo, cargo, 7100 tons, for Elder, Dempster and Co., Limited, Liverpool; Cavina, twin screw, 6800 tons, for Elders and Fyffes, Limited, London; Swanley, single-screw motor cargo vessel, 6700 tons, built by Barclay, Curle and Co., Whiteinch, with double-acting Diesel engines, by the North British Diesel Engine Works, for Harris and Dixon, London; Arkoona, cargo, 4000 tons, for the Adelaide Steamship Company, Adelaide, Australia. Since the resumption of activity last year, work has proceeded without interruption, and the figures for the first three months of this year show what can be accomplished under such conditions. The figures referred to, namely, thirty-eight vessels of 105,742 tons aggregate, are not far behind the average pre-war returns for the same period. During the past few weeks, however, the possibility of an unbroken period of activity has become very uncertain, in view of the application for a wages advance of 10s. per week, and the trouble that may arise out of the strike at Southampton. A fair number of new orders were reported during March, but it is said that many more might have been secured if builders had not been bound to consider the questions of higher costs and stoppages when submitting tenders. New orders are gratifying, but many more will be needed to fill the berths vacated by vessels launched during the past few months. New contracts include two vessels of over 10,000 tons, one of 8000 tons, and two of over 5000 tons.

Steel and Iron Markets Unchanged.

Nothing has occurred to brighten the outlook in the steel market. The continued unsatisfactory labour aspect is all against any improvement, and until the industrial air is clear of disputes better conditions are impossible. Steel works are not getting the shipyard orders anticipated, and specifications against existing contracts are not coming forward very regularly. Steel plates are very quiet, and if sections are somewhat better off, they are still far from being satisfactory. Steel makers report a fair export demand for thin gauges, but a scarcity of orders for heavy sizes. Galvanised sheets are moderately active at slightly easier prices f.o.b. Glasgow. Bar iron has made no progress. The works are comparatively active on existing contracts, but find new business distinctly difficult to secure. Re-rolled steel has been a little more in evidence of late, but prices have to be severely cut. Pig iron has been comparatively steady at last week's prices, the uncertain labour outlook having apparently arrested the downward tendency of prices. Inquiries are fair enough, but orders are no more plentiful, and stocks continue to accumulate. Continental competition has not been so apparent of late, but owing to local industrial conditions home producers have reaped little benefit.

Coal Prices Firmer.

The uncertainty in the coal trade continues to have a firming effect on the market. The collieries are heavily sold, and have little in the way of prompt fuel for disposal. The inland demand quickly absorbs any supplies coming on the market, and quantities of fuel held up owing to the coal trimmers' strike have been diverted to home consumers. Local quotations for home deliveries are increasing, round coals for industrial purposes being about 2s. per ton dearer, and household fuel 1s. per ton above recent prices. Shipments have been greatly reduced, especially on the East Coast, where cargoes from the Lothians and Fifeshire together did not exceed 50,000 tons. Aggregate shipments amounted to 145,545 tons, against 264,474 tons in the preceding week and 388,448 tons in the same week last year. Despite the help of voluntary workers, congestion of a serious nature could not be avoided. Many pits in the East of Scotland have been rendered idle, and numerous vessels are held up.

Cement for Clyde Dock.

The Glasgow Iron and Steel Company, Limited, Wishaw, has secured the contract for the whole of the cement required in connection with the construction of the new Shieldhall Dock at Govan.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE position has not materially changed as compared with a week ago, as it is still highly charged with uncertainty and anxiety so far as the commercial side of the industry is concerned. Hopes were entertained that by this time something definite would have been learned which would have enabled the trade to know what future action to adopt respecting business, but the outlook is as difficult as ever, and operations are held up. The uncertainty is strangling business, and incalculable damage has already been done. The Americans are making their plans to secure orders from Europe and South America, which in the ordinary course of events would have come to this country, while the quantity of German coals which are now finding their way to Italy and other countries causes considerable apprehension in the minds of exporters from South Wales. Quite recently it was reported that 200,000 tons of shipping had been chartered to load German coals from Rotterdam, of which quantity, about half was destined for Italian ports. This cannot but have a very serious effect upon the amount of business which can be done from South Wales, even assuming that there is no trouble with the miners. There is practically no demand from the Continent for supplies of coal from this district, and foreign buyers show already that they are not disposed to purchase from this district for forward delivery, as they naturally assume that there will be a fall in prices, and that if they should require coals it would pay them to hold off for the time being.

Concessions to Miners.

Following on the decision of the national delegate conference in London last week, to ballot the miners on the coalowners' offer, there were meetings on Monday last of members of the South Wales Coalowners' Association and of the Executive Committee of the South Wales Miners' Federation at Cardiff. In the case of the latter body, all that was done was to convene a delegate conference of the miners for Saturday next, when a report of the negotiations and explanations of the terms offered by the coalowners will be given. South Wales coalowners, however, made a further contribution towards a settlement of the miners' demands. They approved the action of the Negotiating Committee in further increasing the minimum wage offer from 30 to 32½ per cent. upon the standard, though they were apprehensive of the effect this would have upon the collieries, as it is stated that most of them have sold quite half of their outputs up to the end of the year, and it is estimated that at least an extra 3s. per ton will be required on the unsold portion of their output to meet the cost of the owners' offer. However, the South Wales coalowners gave consideration to the position of the workmen who lose a shift or shifts in a week, and thereby forfeit the subsistence wage for the remaining shifts worked, this arrangement being in accordance with the award of Earl Buxton. They came to the decision that if the miners accept the proposed terms already offered, they will withdraw the penalty for absence from work. This means that an adult workman, married or single, will not receive less than 8s. 0½d. per shift worked, whether he works full time or not. It was also resolved that continuous shift men—men who work seven shifts per week—shall be paid the subsistence wage, so that they will not be paid less than 8s. 0½d. per shift worked. These are very substantial concessions, and will benefit thousands of workmen, and, of course, further increase the amount of wages payable by the owners. These concessions will be laid before the delegate conference of the men on Saturday.

Dowlais Steel Works.

Grave fears are entertained that if the Dowlais Steel Works at Merthyr are not closed down altogether, before very long, at least, the men will suffer a good deal of short time. At the moment, they have work in hand to keep a fairly large body of workmen engaged, but the trouble is that new orders are not coming along, and the outlook in this respect is very bad, owing to the continental competition. Thousands of tons of continental iron and steel are being imported into South Wales every week at prices which are below the cost of producing iron and steel in this district. It is stated that sectional steel has been sold at £7 per ton delivered in the United Kingdom, whereas it cannot be produced by the best equipped works in this country at much less than £9 per ton. The increased cost of coal and coke which will follow the higher wages to the miners will further handicap steel makers.

Coal Trimmers' Demands.

The Shipping Federation has received from the National Transport Workers' Federation an application for an increase of 13½ per cent. on the present coal-trimming tariff, which, if granted will, bring the trimmers' rates of pay in the United Kingdom to within 20 per cent. of the national coal-trimming tariff, which was brought into operation in the second half of 1920. The trimmers have suffered three reductions, totalling 33½ per cent. in their original post-war tariff, and when the third shift was introduced in June, 1923, the trimming rates in this district were stabilised until June next.

Colliery Developments.

It is announced that contracts have been signed by F. Piggot and Sons, of Bath, and formerly of South Wales, for the sinking of several collieries in the Sirhowy Valley for the Tredegar Iron and Coal Company, Limited. The operations are to commence after the Easter holidays at Gellyroes, Monmouthshire, where the company has two pits. It is stated that the preliminary expenditure involved in this enterprise is about half a million pounds.

Current Business.

Business on the steam coal market has certainly been quieter this week than last, and the reason is that, apart from the paucity of the inquiry from abroad, the collieries have extremely little coal to offer, as they are so tightly stemmed. There is no doubt that they are very full right up to the end of this month. Loading pressure at all the docks is very heavy, and quite a number of steamers are waiting to get into loading berths. The amount of tonnage on offer for employment after the middle of this month is very small, as the Easter holidays restrict the chance of owners getting their steamers away in good time before the end of the month, in case there is trouble with the miners. Furthermore, there is good business from continental ports, where, in addition to the fairly satisfactory rates of freight being offered, steamers are being loaded with much greater rapidity than is the case in South Wales. The superior grades of coal are almost nominal in price for early shipment, best Admiralty large being still firm at 32s. 6d., with best smalls at 23s. There is not much change in patent fuel and coke, but anthracite coals are firmer. Pitwood is not so freely offered, and is steadier.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

BLAKEWAYS, Limited, of P. and O. House, 14–15, Cockspur-street, London, S.W. 1, inform us that they have been asked to act in Great Britain and the Colonies for L'Industrie Metallurgique Sarre et Lorraine, at Sarrelouis.

AT the annual meeting of the Manchester Association of Engineers, held on Friday, March 28th, Mr. Herbert Bates, of the firm of Hulse and Co., Limited, of Salford, was elected president for the year, in the place of Mr. Cecil Bentham, who is retiring pursuant to rule.

CONTRACTS.

THE New Zealand Cabinet has accepted the tender of Sir W. G. Armstrong, Whitworth and Co. for the construction of a section, 18 miles in length, of the East Coast main trunk railway, at a cost of £461,050 10s. The scheme will provide employment for about 400 men.

THE VICKERS-SPEARING BOILER COMPANY, Limited, of 20, Kingsway, W.C. 2, has during the last two weeks been successful in securing orders for four boiler equipments for three separate electricity works, the combined evaporative capacity of the boilers being 132,000 lb. per hour.

GOODWIN, BARSBY AND CO., Limited, of Leicester, inform us that they have just received an order from the Nuneaton Corporation for one of their patented Pyrus cylindrical driers with balanced draught and cyclone dust extracting device, to be used in connection with the Corporation's new tar-macadam plant.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 2 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	5 0 0	5 0 0
Cleveland—		
No. 1	5 0 0	5 0 0
Silicious Iron	5 0 0	5 0 0
No. 3 G.M.B.	4 15 0	4 15 0
No. 4 Foundry	4 11 6	4 11 6
No. 4 Forge	4 10 6	4 10 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 7 6 to 4 10 0	
„ „ Foundry	4 15 0	—
(3) Northampton—		
Foundry No. 3	4 12 6	—
„ Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0	—
Forge	4 7 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 15 0	—
No. 4 Forge	4 14 0	—
Basic	4 10 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 15 0 (a) / 6 0 0 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best „	—	—
N.E. Coast—		
Common Bars	12 0 0	—
Lancs.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 12 6 to 11 15 0	
Gas Tube Strip	12 17 6 to 13 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 10 0	—
Ship Plates, ¾in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ¾in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 5 0†	—
Light „	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 5 0	
„ (others)	9 15 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 0 0 to 10 5 0	—
„ (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	9 15 0 to 10 10 0	
Billets and Sheet-bars	8 0 0 to 8 5 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 0 0 to 18 5 0	
Angles	9 15 0 to 10 0 0	
Joists	9 15 0 to 10 0 0	
Tees	10 15 0 to 11 0 0	
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/6 to 24/9
Block Tin (cash)	257 10 0
„ (three months)	256 10 0
Copper (cash)	65 0 0
„ (three months)	65 17 6
Spanish Lead (cash)	34 7 6
„ (three months)	33 5 0
Spelter (cash)	33 3 9
„ (three months)	33 10 0
Manchester—	
Copper, Best Selected Ingots	71 0 0
„ Electrolytic	72 0 0
„ Strong Sheets	98 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0¼
„ Condenser	0 1 2¼
Lead, English	36 5 0
„ Foreign	34 17 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£23 0 0	8/-
„ 8 p.c. to 10 p.c. „	£22 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£45 0 0	16/-
„ „ 1 p.c. „	£51 0 0	17/6
„ „ 0.75 p.c. carbon	£68 0 0	20/-
„ carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
„ „ 75 p.c.	£17 0 0 scale 6/- per unit	
„ Vanadium	19/6 per lb.	
„ Molybdenum	8/6 per lb.	
„ Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	27/6
„ „ Ell	29/3
„ „ Splint	29/- to 31/6
„ „ Trebles	26/-
„ „ Doubles	25/9
„ „ Singles	23/-
Ayrshire—	
(f.o.b. Ports)—Steam	27/6
„ „ Splint	29/-
„ „ Trebles	26/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	22/9 to 25/-
Screened Navigation	31/-
Trebles	28/9
Doubles	24/9
Singles	23/-
Lothians—	
(f.o.b. Leith)—Best Steam	24/9
Secondary Steam	23/9
Trebles	26/3
Doubles	25/-
Singles	23/-

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		31/-
Household		49/- to 59/-
Coke		38/6
Northumberland—		
Best Steams		26/6 to 27/-
Second Steams		26/-
Steam Smalls		16/-
Unscreened		23/6 to 24/6
Household		26/- to 28/-
Durham—		
Best Gas		25/6
Second		24/-
Household		26/- to 28/-
Foundry Coke		28/- to 30/-
Sheffield—	Inland.	
Best Hand-picked Branch	36/- to 39/-	—
Barnsley Best Silkstone	34/- to 36/-	—
Derbyshire Best Brights	31/- to 35/-	—
„ „ House	27/- to 29/-	—
„ „ Large Nuts	27/- to 28/-	—
„ „ Small „	20/6 to 23/-	—
Yorkshire Hards	27/- to 30/-	—
Derbyshire „	25/- to 28/-	—
Rough Slacks	12/6 to 15/6	—
Nutty „	12/- to 14/-	—
Smalls	8/- to 10/-	—
Blast-furnace Coke (Inland)	29/-	
„ „ (Export)	f.o.b. 31/- to 32/-	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	32/- to 32/6
Second „ „	31/- to 31/6
Best Dry Large	30/- to 31/-
Ordinary Dry Large	27/- to 29/-
Best Black Vein Large	30/- to 31/-
Western Valley „	29/- to 30/-
Best Eastern Valley Large	28/6 to 29/6
Ordinary „ „	27/6 to 28/6
Best Steam Smalls	22/6 to 23/6
Ordinary „	20/6 to 22/6
Washed Nuts	28/- to 30/-
No. 3 Rhondda Large	30/- to 31/-
„ „ Smalls	25/- to 26/-
No. 2 „ Large	25/- to 26/-
„ „ Through	21/- to 23/-
„ „ Smalls	19/- to 20/-
Coke (export)	55/- to 60/-
Patent Fuel	29/- to 32/-
Pitwood (ex ship)	25/- to 26/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	42/6 to 45/-
Seconds	37/6 to 40/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	47/6 to 50/-
Nuts	45/- to 55/-
Beans	46/- to 47/6
Peas	27/- to 30/-
Breaker Duff	12/9 to 13/3
Rubbly Culm	16/6 to 17/-
Steam Coals:	
Large	24/6 to 26/6
Seconds	22/- to 24/-
Smalls	15/- to 18/-
Cargo Through	19/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Restricted Buying.

At the time when the franc appeared to be on the verge of a collapse, consumers were so anxious to place orders for iron and steel that producers refused to quote, and declared that there was no more material available. Mill and forge owners were profiting from the monetary slump to satisfy the heavy demand on account of foreign buyers. In the belief that by exporting as much iron and steel as possible they were helping to strengthen the financial position, manufacturers did not hesitate to give a preference to foreign consignments, with the result that there was little left for home consumers. Now that the franc has undergone an equally sensational recovery, with the help of loans from British and American financial houses, the export trade has fallen off considerably, and producers are anxious to deliver to home consumers, who, however, are little disposed to confirm orders until the situation becomes clearer. Prices on the whole are weaker, but they have declined to nothing like the extent that would seem to be justified by the higher money values.

European Reconstruction.

The idea of the problem of European reconstruction being involved in a settlement of reparations is so far gaining ground that there is much greater promise than formerly of a successful issue to any negotiations that may be carried out to put an end to the present unsatisfactory situation. No one will admit that the Ruhr occupation has been a failure, and figures are frequently published to prove that the French action was justified, but this has not prevented the financial and industrial position on the Continent from going from bad to worse, and the public is being brought to see that the interests of all the countries must be taken into account if each is to enjoy any measure of prosperity. The exclusive attitude so far adopted by this country was based entirely upon self-interest, and it will no doubt continue to render negotiations difficult. Nevertheless, the fact that the recent financial crisis was only staved off with the help of foreign capital has shown people here that nothing can be done without mutual aid.

Cotton.

The Colonial Commission at the Senate has continued its inquiry into the possibility of procuring sufficient cotton from the Colonies, and the evidence given last week tends to show that West Africa must be depended upon as the chief source of supply. More or less successful results have been obtained by private concerns, partly with the aid of subsidies amounting to 7 million francs granted by the Government from the profits on cotton realised during the war. In the opinion of experts, the only way to obtain early results is to render the cultivation of cotton by the natives compulsory, and to increase the yield as much as possible. By compelling the natives to grow cotton, it would be possible to procure 50,000 tons of cotton a year from West Africa alone, and 100,000 tons from all the Colonies. While the inquiry of the Colonial Commission tends to show that early results in the way of supplying the country with cotton can only be obtained by compelling the natives to grow this product, and placing them under the control of specialised engineers, another Commission, appointed by the Academy of Agriculture, concludes that attention should be particularly directed to the carrying out of the various irrigation schemes, which can alone ensure an abundant supply of the material.

Art and Engineering.

The laying out of the Exhibition of Decorative Arts, to be held in Paris next year, was officially begun last week. It will renew the series of Exhibitions, of which the last was the great Universal Exposition of 1900. But as it is no longer possible to group together the products of all industries, the future Exhibitions will be partial in character, and the Paris Exhibition of Decorative Arts will be still further restricted in the sense that the exhibits must be passed by a Committee which will be attached to each group. Notwithstanding this process of selection, the Exhibition will be an extensive one, covering the Esplanade des Invalides and the Cours la Reine, and including the Grand and Petit Palais. This demonstration of decorative art will encroach in many ways upon the domain of engineering. Many of the engineering achievements in this country owe their attraction to the way in which the simplicity of the constructional features is relieved by decoration. The Exhibition was to have been followed by another international gathering in 1926, devoted to the Colonies, but owing to financial considerations, it is by no means certain that the preliminary arrangements will be sufficiently advanced to allow of its being held at that date. There is a desire to postpone the colonial Exhibition, which would follow too closely upon the one held at Marseilles.

Suction Gas Traction.

The possibility of suction gas plants using charcoal as fuel being employed extensively on motor vehicles has raised the question whether the supplies of charcoal will be sufficient to meet the demand without the cost rising to a prohibitive level. In a communication to the Academy of Agriculture, M. Lafosse stated recently that the importance of the charcoal industry in this country had dwindled to a quarter of what it was fifty years ago, and yet the price of the fuel had quadrupled since the war, this being due not only to the depreciation of the franc, but also to the promise of a large demand for charcoal for traction purposes. Although it is expected that the price will continue to increase with the growing consumption, there is a general impression that charcoal will always show a considerable economy over petrol. The possible production of charcoal in this country is estimated by M. Lafosse at 750,000 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

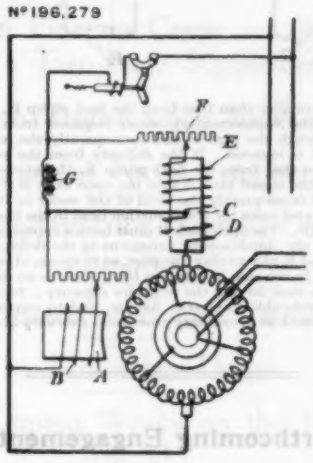
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

196,279. April 10th, 1923.—IMPROVEMENTS IN OR RELATING TO DYNAMO-ELECTRIC MACHINES, *The Metropolitan-Vickers Electrical Company, 4, Central-buildings, Westminster.*

This specification describes a method of improving the commutation of electrical machines under abnormal conditions. The diagram shows the scheme applied to a rotary converter. The converter is provided with main polar projections A carrying a winding B which is excited from the mains through a rheostat and with interpolar projections C, which are provided with a series commutating winding D and an auxiliary commutating winding E. The auxiliary winding E is excited, through a variable resistance F, across a highly inductive impedance device G, which is connected in series with one of the direct-current mains, and which may be either a self-inductance device or a transformer.—*February 28th*, 1924.

Nº 196,279

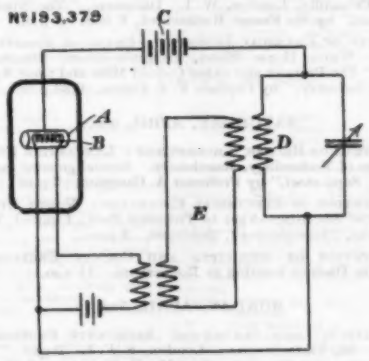


TELEGRAPHS AND TELEPHONES.

193,379. November 7th, 1922.—IMPROVED MEANS FOR GENERATING ELECTRIC OSCILLATIONS, Gesellschaft für Drahtlose Telegraphie, m.b.H., and Otto von Bronk, both of 9, Tempelhofer Ufer, Berlin.

The valve contains a cylindrical anode A and a spirally wound cathode B. The anode is connected through the battery C and a tuned oscillatory circuit D to the cathode B. The circuit D is coupled through an intermediate circuit E to the heating circuit of the cathode B. The oscillations in the circuit D thus act through the back coupling circuit E on the cathode B, so that the emission of electrons decreases and increases in rhythm with the oscillations occurring in circuit D. The current flowing from the anode to the cathode is correspondingly controlled. In order to influence as effectively as possible the emission of electrons it is preferable to employ electrodes having large surfaces and arranged near together and to form the cathode of coiled wire which possesses as small heat capacity as possible.—*February 7th*, 1924.

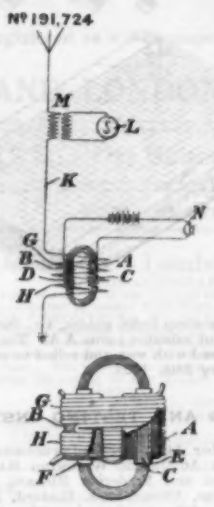
Nº 193,379



191,724. January 8th, 1923.—IMPROVEMENTS IN OR RELATING TO MAGNETIC MODULATORS FOR HIGH-FREQUENCY CURRENTS, *The British Thomson-Houston Company, Limited, of Crown House, Aldwych, London, W.C. 2.*

This invention relates to modulators of high-frequency current, and more particularly to modulators of the type commonly known as magnetic amplifiers. The improved modulator comprises a pair of coils A and B surrounding the two legs C and D of a closed magnetic core made up of thin laminations. In constructing this modulator the coils A and B are first wound upon the spools E and F and then placed side by side. The core is then formed by threading a thin ribbon of the desired magnetic material continuously through the spools E and F, a sufficient number of turns of this ribbon being made to furnish the desired cross section of the magnetic core. This ribbon may be made of electrolytic iron or mild steel, rolled down to a thickness of about 1 mil and enamelled, the enamel furnishing the desired insulation between the turns of the ribbon. Surrounding the coils A and B is a winding made up of portions G and H wound in opposite directions. This winding is connected in series with a radiating antenna K, which is supplied with high-frequency current from a source L through the usual coupling transformer M. The source L may be of any form desired; a high-frequency alternator, an arc generator, or a vacuum tube generator. Modulation of the antenna current is effected by supplying a telephone current by means of a transmitter N and a local battery to the windings A and B.—*February 21st*, 1924.

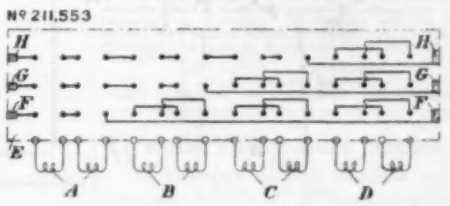
Nº 191,724



211,553. November 17th, 1922.—IMPROVEMENTS IN ELECTRIC INDUCTANCE COILS AND THE LIKE, Hugh Percival Thompson Lefroy, of the Air Ministry, Alexandra House, Kingsway, W.C.

According to this invention an inductance coil is composed of a number of sections, each divided into two parts, which are associated with a switch for connecting all the elements in series so as to assist one another and also for connecting the elements in parallel so that they oppose one another, the current only passing through the elements in series. A B C D are the separate sections, which are divided into two separate elements or coils having terminals indicated by circles. The coils are associated with a barrel switch E. The switch is provided with rows of contacts indicated by black dots connected in separate combinations by the wiring indicated by heavy lines. It will be seen that the bottom row of contacts when turned against the terminals of the coils connects the pair of elements A in series and the elements of each other pair B C and D in parallel. When turned against the terminals the middle row of contacts of the coils connects the pairs of elements A and B in series and the elements of each other pair C and D in parallel. When turned against the terminals of the coils the top row connects the pairs of elements A, B and C in series and the pair of elements D in parallel. In every case the current only passes through the sections in series and not through the sections in parallel. The numbers of pairs of elements and the numbers of rows of contacts may be varied. F F, G G, and H H indicate the lead connections from the inductance.—*February 18th*, 1924.

Nº 211,553

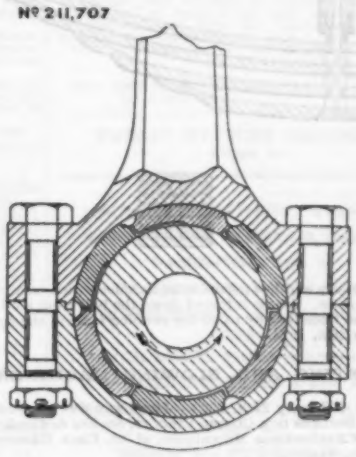


TRANSMISSION OF POWER.

211,707. February 26th, 1923.—JOURNAL BEARINGS, J. C. Briggs, Air Ministry, Alexandra House, Kingsway, London, W.C. 2.

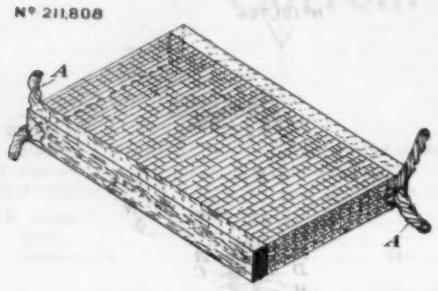
According to this invention a connecting-rod big end bearing or other journal bearing comprises a series of unsymmetrically supported bearing segments mounted so that they are carried around with the journal about the journal axis and within the connecting-rod big end, the plummer block or the like. This construction facilitates the entry of lubricant between the connecting-rod big end and the bearing segments at the leading edge on the convex face of the bearing segments, where the working surfaces are of large diameter. Further, the unsymmetrical support for each bearing segment permits the bearing segment to tilt slightly on the journal periphery or surface without appreciable wear of the latter.—*February 28th*, 1924.

Nº 211,707



211,808. September 24th, 1923.—Woven Belting, H. R. Turner, Spotland, Rochdale.

In order to protect the edges of woven belting against wear

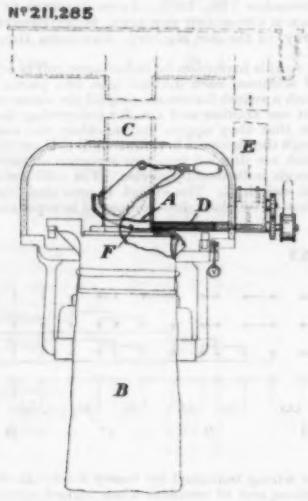


through friction on strap forks, guides, &c., the inventor weaves into the edges stout asbestos yarns A A. The edges are subsequently impregnated with wax and rolled to make them homogeneous.—*February 28th*, 1924.

MEASURING AND TESTING INSTRUMENTS.

211,285. December 14th, 1922.—Improvement in or connected with Automatic Weighing Machines, William George Simon and Frederick Richard Simon, both of Phœnix Works, Vernon-road, Basford, Nottingham.

This invention relates to that class of automatic weighing machines in which a shutter is operated to close the feed to a sack or pan suspended from a scale beam on the lowering of the beam, the final weighing being effected by a dribble feed through the shutter. The main supply shutter A or valve is unperforated.

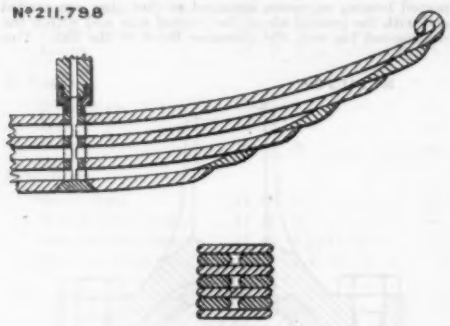


When the major portion of the weighing is completed no more material can pass into the pan or sack B from the main trunk C of the machine. The dribble feed is supplied by the screw D, which gives a regular supply, the feed being either through a shaft E from the screw above which provides the main feed to the machine, or from any other convenient source. The termination of the dribble may be effected by means of a second shutter F or valve or by the stopping of the feed screw D.—*February 21st*, 1924.

MOTOR CARS AND ROAD TRAFFIC.

211,798. August 10th, 1923.—Leaf Springs, R. Burger-Weber, Burg, Aargau, Switzerland.

In order thoroughly to lubricate the spring the inventor slots each alternate leaf nearly to the end, as shown in the section. The edges of the slots are well rounded. The central bolt is

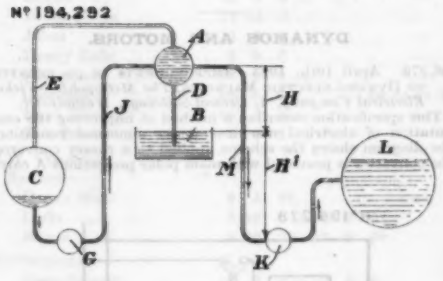


drilled axially and has ports cut in its sides which communicate with the slots. Grease is forced down the bolt from a lubricator above and finds its way to all the rubbing faces of the spring.—*February 28th*, 1924.

PUMPING AND BLOWING MACHINERY.

194,292. February 28th, 1923.—Improved System for Feeding Boilers in a Closed Circuit, Société de Condensation et D'Applications Mécaniques, of 10, Place Edouard VII., Paris, France.

The essential feature of this feed system consists in the use of a closed tank connected directly, i.e., without intermediate valves, to the feed tank, to the air pump of the condenser, to the pressure pipe of the pump for the water of condensation, and to the suction pipe of the boiler feed pump. The boiler feed system shown diagrammatically comprises a closed tank A permanently connected to the feed tank B by the pipe D; to the air pump of the condenser C by the pipe E; to the force pipe of the pump G for the water of condensation by the pipe J; and finally to the suction pipe of the feed pump K of the boiler L by the pipe M. The feed tank B is usually arranged at a higher level than the pumps G and K, the difference of level being represented by H^1. The syphon at the upper part, the height of which is represented by H, is maintained constantly in action owing to the connection E. In the case shown in this connection E is not very high with respect to the closed tank A, and there is a small return flow of water from the closed tank A to the condenser C. By employing a syphon of suitable height—for instance, a height greater than that corresponding to atmospheric pressure—no water will flow back from the closed tank A to the condenser C. If the pump G for the water of condensation and the feed pump K give similar deliveries, the level of the water in the open tank B is not affected, as the feeding circuit is closed through the closed tank A. If the delivery from the



pump G is smaller than that from the feed pump K, the latter will draw the supplementary water required from the open tank B through the pipe D and consequently the level of the water in B is lowered. If the delivery from the pump G is greater than that from the feed pump K, the excess of water flows from the closed tank A into the open tank B through the pipe D and consequently the level of the water in B is raised. In these several cases the static suction head in the feed pump K is equal to H^1. The open tank B must have a capacity sufficient to allow of the simultaneous variations in the deliveries of the pumps G and K and to play the part, so to speak, of a hydraulic fly-wheel. In the case of plant on land, there is no difficulty in providing a tank having the requisite capacity; but on board ship it is preferable to restrict its size, and to connect it with the reserve tank as in ordinary practice.—*February 21st*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the time and place *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Resumed discussion on "Mechanical Methods of Boiler Firing." 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Mineral Oils, with Special Reference to Lubricating and Insulating Oils," by Mr. A. J. Sear. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Paper, "Various Aspects of Internal Combustion Engines," by Engineer-Commander C. J. Hawkes. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Nucleus of the Atom," by Sir Ernest Rutherford, F.R.S. 9 p.m.

Society of Chemical Industry: Chemical Engineering Group.—White Horse Hotel, Congreve-street, Birmingham. Paper, "The Premier and other Colloid Mills and their Applications in Industry," by Captain F. J. China. 6.30 p.m.

SATURDAY, APRIL 5th.

Institute of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. Annual general meeting. Paper, "Semi-steel," by Professor A. Campion. 3 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—Visit to Thwaites Bros., Limited, Vulcan Ironworks, Thornton-road, Bradford. 3 p.m.

Institution of Municipal and County Engineers.—Yorkshire District meeting at Rotherham. 11 a.m.

MONDAY, APRIL 7th.

Architects' and Surveyors' Assistants Professional Union.—92, Victoria-street, London, S.W. 1. Paper, "Municipal Engineering Quantities," by Mr. H. R. Sayer. 6.30 p.m.

Institute of Transport.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Organisation of Traffic and Locomotive Departments in Relation to Running," by Mr. H. A. Watson. 5.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. General meeting. 5 p.m.

Society of Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Gas Firing (Flame Control)," by Mr. A. C. Ionides. 5.30 p.m.

Surveyors' Institution.—12, Great George-street, London, S.W. 1. Paper, "The Place of Arterial Land Drainage in Agriculture," by Mr. C. A. J. Clayton. 8 p.m.

TUESDAY, APRIL 8th.

Institute of British Foundrymen: Burnley Section.—Municipal College, Ormerod-road, Burnley. Annual general meeting. 7.15 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. "Observation Notes on a 20,000-ton Ship with Oil Engines and Electric Propulsion," by Mr. P. J. Higgs. 6.30 p.m.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting. 7.30 pm.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Discussion, "Standards of Comparison in Connection with the Thermal Efficiency of Internal Combustion Engines," introduced by Mr. G. J. Wells. 6 p.m.

Institution of Electrical Engineers: North Midland Centre.—Hotel Metropole, King-street, Leeds. Annual general meeting, followed by a smoking concert. 6.45 p.m.

Institution of Petroleum Technologists.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Crude Oils of Burmah and Assam," by Mr. W. J. Wilson. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Papers, "An Account of a Fire in the Bickershaw 7ft. Mine at Leigh, and its Action upon the Coal," by Messrs. M. Ashurst and F. N. Siddall; "The Evolution of Ammonia Nitrate Explosives," by Mr. John Smith. 4 p.m.

WEDNESDAY, APRIL 9th.

Institution of Automobile Engineers.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Lecture, "Traction Across Rough and Roadless Country," by Mr. L. A. Legros. 6.30 p.m.

Institution of Civil Engineers.—Students' visit to the works of General Motors, Limited, Hendon.

Institution of Naval Architects.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7.30 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, London, E.C. 4. Paper, "Ambrose and John Crowley—Citizens and Ironmongers of London, 1682 to 1728," by Mr. W. A. Young. 5.30 p.m.

Radio Society of Great Britain.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. Discussion on "The Use of Rectified Alternating Current as a Substitute for Accumulators and Dry Batteries in Receiving Circuits," opened by Mr. L. F. Fogarty. 6 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, London, S.W. 7. General meeting. 5 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "The Free Pendulum," by Mr. F. Hope-Jones. 8 p.m.

WEDNESDAY to FRIDAY, APRIL 9th to 11th.

Institution of Naval Architects.—Royal United Service Institution, Whitehall, London, W.C. 2. Annual general meetings. For programme see page 342.

THURSDAY, APRIL 10th.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85-88, The Minories, Tower-hill, E. 1. Paper, "Failures in Metals and Alloys," by Dr. G. H. Gulliver. 8 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. London graduates' meeting. Paper, "The Principles and Practice of Automobile Insurance," by Mr. T. P. Whitcomb. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Power Circuit Interference with Telegraphs and Telephones," by Mr. S. C. Bartholomew. 6 p.m.

Institution of Mining and Metallurgy.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Annual general meeting. Presidential address by Dr. H. M. Morgans. 5.30 p.m.

FRIDAY, APRIL 11th.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. Annual general meeting. 6.30 p.m.

Institute of Metals: Sheffield Local Section.—The University, St. George's-square, Sheffield. Annual general meeting. Paper, "The Protection of Aluminium by Electroplating," by Mrs. A. Vellan and Professor C. H. Desch, F.R.S. 7.30 p.m.

Institution of Locomotive Engineers.—College of Technology, Sackville-street, Manchester. Lecture, "Some Impressions on the Manufacture of Superheaters," by Mr. R. W. Whittle. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate London, S.W. 1. "The Relation of Air Consumption to Brake Horse Power in Internal Combustion Engines," by Dr. H. Moss. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Discussion on Mr. J. M. Jockel's paper, "Water-tube Boilers." 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "Colours, Stains and Dyes," by Professor Jocelyn Thorpe. 9 p.m.

SATURDAY, APRIL 12th.

Institute of British Foundrymen: Lancashire Branch.—Visit to the works of the London, Midland and Scottish Railway at Horwich. 2.45 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. "Leonardo Da Vinci as a Man of Science," (Lecture II.), by Dr. Charles Singer. 3 p.m.

MONDAY, APRIL 14th.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Paper, "Light Alloys for Pistons and Connecting-rods," by Dr. L. Aitchison. 6.45 p.m.

TUESDAY, APRIL 15th.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Annual general meeting. 7 p.m.

Institution of Automobile Engineers: Coventry Centre.—Railway Hotel, Coventry. Paper, "Light Alloys for Pistons and Connecting-rods," by Dr. Leslie Aitchison. 6.30 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—Technical College, Bradford. "The Protection of Alternating-current Transmission and Distribution Systems," by Mr. R. J. Huntley. 7 p.m.

Institution of Engineers and Shipbuilders in Scotland.—Rankine Hall, Elmbank-crescent, Glasgow. Paper, "Sliding Cylinder Double-acting Diesel Engines," by Mr. J. C. M. MacLagan. 7.30 p.m.

FRIDAY, APRIL 25th.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Aluminium Electrical Conductors for Overhead Power Transmission," by Mr. H. G. Williams. 7.30 p.m.

TUESDAY, APRIL 29th.

Institution of Electrical Engineers: North Midland Students' Section.—The University, Leeds. Annual general meeting. 7 p.m.